Fall 12-11-2018

Scientists With and Without Managerial Responsibilities: How Managerial Training Affects the Perception of Job Satisfaction

Jamie Humphries

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Scientists With and Without Managerial Responsibilities: How Managerial Training Affects the Perception of Job Satisfaction

by

Jamie Keith Humphries

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

Executive Doctorate in Business

In the Robinson College of Business

Of

Georgia State University

GEORGIA STATE UNIVERSITY

ROBINSON COLLEGE OF BUSINESS

2018

ACCEPTANCE

This dissertation was prepared under the direction of the *JAMIE KEITH HUMPHRIES* Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ACKNOWLEDGEMENTS

I would like to thank Dr. Patricia Ketsche for her guidance and robust challenges during the course of this dissertation. I would also like to express gratefulness to my committee members Dr. Karen Loch and Dr. Pam Ellen for their invaluable input and advice.

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LIST OF ABBREVIATIONS

J Richard Hackman and Oldham (1974) provide the following definitions.

1. Job Diagnostic Theory proposes the interactive relationships between Core Job Characteristics, Critical psychological states, and Personal/Work Outcome.
2. Core Job Characteristics refers to objective properties of Skill Variety, Task Identity, Task Significance, Autonomy, and Feedback that contribute to the work effectiveness and satisfaction of employees.
3. Critical Psychological States refers to the Experienced Meaningfulness of Work, Experienced Responsibility for Work Outcomes, and the Knowledge of Work Results.
4. Personal Work/Outcomes refers to the personal, affective reactions or feelings a person obtains from performing a job.
5. Affective Reactions refers to the general and specific satisfaction, and internal work motivation experienced as a result of doing a job.
6. Internal Work Motivation refers to the degree to which the employee is self-motivated to perform effectively on the job.
7. General Satisfaction refers to the overall measure of the degree to which the employee is satisfied and happy with the job.
8. Specific Satisfaction refers to some short scales which provide separate measures of satisfaction with job security, pay and other compensation, peers and co-workers, supervision, opportunities for personal growth, and development on the job.
9. Motivating Potential Score refers to a single summary index of the degree to which the objective characteristics of the job will prompt high internal work motivation.

10. Growth-Need Strength refers to the desire of the individual to obtain professional growth and achievement.
11. Skill Variety is the degree to which a job requires a variety of different activities in carrying out the work, which involves the use of some different skills and talents of the employee.
12. Task Identity is the degree to which the job requires the completion of a "whole" and identifiable piece of work (i.e., doing a job from beginning to end with visible outcomes).
13. Task Significance is the degree to which a job has a substantial impact on the lives or work of other people whether in the immediate organization or the external environment.
14. Autonomy is the degree to which the job provides substantial freedom, independence, and discretion to the employee in scheduling his or her work and in determining the procedures to be used in carrying it out.
15. Feedback refers to the degree to which carrying out the work activities required by the job results in the employee obtaining information about the effectiveness of his or her performance.
16. Meaningfulness of Work refers to the degree to which the employee experiences the job as one which is generally meaningful, valuable, and worthwhile.
17. Experienced Responsibility refers to the degree to which the employee feels accountable and responsible for the results of the work he or she does.
18. Knowledge of Results refers to the degree to which the employee knows and understands, on a continuous basis, how effectively he or she is performing his or her job.

ABSTRACT

Scientists With and Without Managerial Responsibilities: How Managerial Training Affects the Perception of Job Satisfaction
by
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December 2018

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Frequently scientists are promoted into positions that require them to assume management responsibilities without preparative training for a successful transition into management or other leadership roles. The movement into non-scientific roles may adversely affect the satisfaction of scientifically trained members of the organization, especially if they lack prior managerial training. Undergraduate science curricula do not introduce the basics of leadership skills, and therefore, scientists are first introduced to the concepts of management when delegated management responsibilities. Few scientifically focused organizations provide management training before the individual's transition to their first management role. Those organizations providing training seldom introduce appropriate levels of instruction for employees not accustomed to managerial tasks (Biddle & Roberts, 1994). Thus, scientists find themselves responsible for acquiring the needed training to develop and enhance their management skills. Scientists seeking to fill the gap in knowledge may pursue training through professional associations, conferences, self-teaching, and formal education such as graduate level coursework. These endeavors may or may not be formally supported by their organizational leadership or human resources department. Therefore, conflicting organizational expectations and employee efforts may occur, which may decrease overall job satisfaction. Herzberg states that organizations that fail to develop role structures that

allow for advancement of knowledge for new roles dramatically increase the chances for job dissatisfaction and turnover in the initial leadership ranks.

According to Roberts and Biddle, approximately thirty percent of those who transition from technically oriented roles to the first levels of leadership transition back to technical roles for a period. Most often such transitions involve leaving the organization that promoted them to the initial management roles. Biddle and Roberts apply the fundamental tenet of the Job Characteristics Theory and find that fundamental job characteristics such as Skill Variety, Task Identity, and Task Significance are reported at high levels by individuals retained by their organizations.

The creation of conflicting role expectations could be avoided by appropriately characterizing the elements of the work and inherent variety of skills needed by the individuals selected for advancement. This process would then inform both the individual and the organization of the types of training to pursue and the appropriate level of support from the organization to ensure the attainment of goals by each party.

The use of the Job Characteristics Theory allows organizations to identify the components of roles that scientists hold high in value. The identified components may be used to develop roles that include elements that scientists find meaningful. Also, organizations can structure managerial training programs that bring meaningfulness to managerial tasks.

This study contributes to the literature by studying an understudied group of workers (scientists) and by using Job Characteristics Theory as a tool to measure employee perceptions of specific components of the job, how those translate into motivations or job satisfaction, and thus providing specific insight into the scientific world. The existing literature on dissatisfaction concerning managerial responsibilities comprised of older studies focusing primarily on engineers.

Though engineers and scientists share many similarities in innovation creation, a critical difference in scientists is that they occupy knowledge creation and interpretation roles. Engineers create tools which can be used to improve processes or to enhance the functioning of other tools. Applied engineers in many aspects focus their work on improving process, troubleshooting, and repair of devices. A large number of studies found in the literature review focus on engineers and scientists concerning research and development activities. In this context, scientists and engineers typically work hand in hand. Therefore their usefulness as analogs is correct. However, applied scientists utilize the tools developed by engineers and the data collected to produce empirical results that might be deeply meaningful. The difference in the applied areas of science and engineering leads to the need to study each individually as the tasks and focus of work differ. This study addresses the gap in the literature by focusing specifically on scientists using a robust theoretical approach.

The cited works primarily focus on elements of Herzberg's Two-Factor Theory. None have utilized the Job Characteristics Theory to characterize job satisfaction in engineers or scientists. This author's study applies a more precise theory to investigate the influences of specific job characteristics on the job satisfaction and the role of managerial training to overall job satisfaction.

The results of the study found that scientists in managerial roles perceive lower overall job characteristics than scientists in technical roles. However, among scientists in managerial roles, managerial training had a significant positive influence on the perception of Skill Variety, Task Identity, and Task Significance. The study revealed evidence that managerial training had a positive effect on the job satisfaction of scientists in managerial roles through indirect effects in job characteristics. Moreover, we observed a higher number of scientists returning to technical roles from management roles than reported in previous literature.

INDEX WORDS: Scientist, Management, Job Diagnostic Survey, Job Characteristics Theory

I CHAPTER I - INTRODUCTION

I.1 Dissertation Outline

The Dissertation is organized into six primary chapters: 1) this Introduction section which provides an outline and summary of the Dissertation, 2) a Literature Review chapter which provides the theoretical framing and buildup of the applicable theory, 3) the application of the Job Characteristics theory to the problem, 4) the Methods section describes the study's methodology and analytical approach and utilized techniques, 5) the Discussion section contains the analysis and results of the utilized analytical techniques, and 6) the Conclusion chapter concludes the Dissertation with the author's view on limitations, some recommendations for future research, and a summary of the Dissertation.

I.2 The Problem

During their careers, scientists are often faced with a choice to move into managerial roles or remain in technical roles. Scientists may face a need to increase compensation or other supporting hygiene factors, and their organization may not have developed dual-ladder career paths for scientists. Therefore, management paths are the only choice for advancement. Organizations may need managers, and scientists that are technically proficient are asked to fill the need whether prepared or not. Such situations present new challenges to technically oriented individuals. The ability to view the tasks in the new role as being relevant to the advancement of the individual or the attainment of organizations goals affects the perception of job satisfaction.

There is longstanding evidence that scientists experience difficulties in the transition from scientific roles to management positions across various types of organizations, including government institutions, and private entities (Bayton & Chapman, 1972; Holt & Ferber, 1964). These difficulties affect both men and women. Liu, Englar-Carlson, and Minichiello (2012)

discuss the challenges faced by midlife men in the movement from the technically proficient roles to managerial roles where the cost of excelling at science blocks upward mobility. Women in scientific roles experience additional hindrances in their career paths due to marriage and child-rearing. Though marriage and family influence the careers of both genders, women suffer disproportionally (England, Bearak, Budig, & Hodges, 2016; Wolfinger, 2013).

The differences in job characteristics between a technical role and a managerial role in most organizations are vast. It is possible that organizations with scientific missions fail to construct managerial roles that take into account the inquisitive nature of scientists. The career paths of the scientists in a technical track often are truncated by the lack of a dual ladder. In many instances, the only growth in responsibility, wages, and organizational recognition available to the scientist is through a managerial role. The movement of high performing scientists into managerial roles in many cases yields a mediocre manager that is dissatisfied with themselves and the organization (Biddle & Roberts, 1994; Roberts, 1994). Organizations that fail to incorporate a structured educational system for roles outside of the primary training of individuals, risk enhanced job dissatisfaction and increased risk of turnover. (F. Herzberg, 1968)

The educational system for scientists trains individuals to solve questions in a particular field of inquiry. The classical model teaches future scientists how to solve exciting and challenging problems as independent contributors or as a close-knit group. The testing and probing for a solution may have various approaches; however, the solution lies within the arena of scientific training (M. Badawy, 1996; M. K. Badawy, 1971). The educational pathway developed by modern institutions rarely introduces aspiring scientists in the early stages of their educational pursuits to necessary managerial skills. There exists little training in the area of adaptive and unstructured problems that arise from the social areas of work. The curriculum of

most physical science degrees does not prepare individuals for a future where management is a reality. This author conducted a review of twenty-five curriculum schedules for physical science undergraduate and graduate degrees at leading schools in Texas, California, and Massachusetts and found no leadership components (Appendix A). This author's selection of schools included the top twenty-five institutions in the graduation of individuals into the natural sciences in states that have significant chemical and biological industries in both research and production as indicated by the 2015 C&E News Employment and Salary Survey administered by the American Chemical Society.

In contrast, approximately twenty percent of engineering programs at the same schools offer a fifth-year program at the undergraduate level with basic managerial courses included, as shown in Appendix B. Pons (2015) study of practicing engineers shows a growing emphasis on managerial training in the engineering world acknowledged throughout the experience levels of the engineers. The study shows the more engineers gain experience, the higher they express the need for undergraduate managerial training.

A scientist that moves into a management role and leaves scientific tasks behind may become less satisfied due to a lack of preparation for the management tasks and difficulties as a result of weak interpersonal skills (M. Badawy, 1996; Biddle & Roberts, 1994; Mainiero, 1986). The individuals in technical roles are perceived experts in the specialized field based on their training. The movement into management, whether voluntary or involuntary, may place stress on the confidence of the individual in performing new tasks assigned to the new role. The inability to identify new managerial tasks as contributing to the organization's success forms a basis for job dissatisfaction (Goldberg, 2006; Mainiero, 1986). The inability to relinquish tasks of the previous role may negatively influence job satisfaction. The need to gain satisfaction from

the aspect of individual contributor tasks weighs heavily on many front-line managers (Charan, Dotter, and Noel, 2010). Several studies have found that approximately thirty percent of engineers, computer scientists, and scientists leave their current employment once they have transitioned into the first level of management to reenter technical roles in a different company due to dissatisfaction with managerial tasks (Liu et al., 2012; Mainiero, 1986).

Though engineers and scientists share many similarities in innovation creation, a critical difference in scientists is that they occupy knowledge creation and interpretation roles. In contrast, engineers create tools for use which utilize knowledge to improve other tools and to improve processes (Jonassen, Strobel, & Lee, 2006; Passow, 2012). Applied engineers in many aspects focus their work on improving processes, troubleshooting, and repair of devices. The difference may allow engineers to make the transition to management roles more seamless as engineers have a mindset of governance to various processes. The mindset functions a link between the management of devices and procedures to equate with the management of individuals.

II CHAPTER II - LITERATURE REVIEW

II.1 Scientists Who Transition to Management

The above evidence was provided to show that scientists frequently are promoted into positions that require management responsibilities without receiving training and preparation to be successful in their management roles. The movement into non-scientific roles may affect the satisfaction of scientifically trained members of the organization. Undergraduate science curriculums do not introduce the basics of leadership skills, and therefore, students are first introduced to the concepts of management when delegated management responsibilities.

Kakar (2018) and Kumar (2011) studied software engineers and knowledge workers respectively. They apply the Job Characteristics Theory (explicated below) and find that the autonomy and feedback characteristics are critical to the job satisfaction of these individuals. The roles that are constrained and do not allow for the use of skills acquired adversely affect perceived autonomy and feedback. Skill variety is an essential factor of the study in that individuals must perceive they have the right skills or that the organization supports their ability to gain new skills to be successful. However, the ability to have autonomy, defined as the ability to be creative in solving problems and perceive a high level of self-determination is a crucial element to job satisfaction. Study participants preferred the Agile Development Method (Kakar, 2018) for daily processes in work as it allows for rapid and constant feedback from peers, managers, and customers. The feedback characteristics of this methodology reinforce the autonomy characteristics in perceived self-determination. These studies support the application of the Job Characteristics Model to scientists in technical roles as the creation and assessment of data to produce new knowledge is a common responsibility (Kakar, 2018).

Charan, Dotter, and Noel (2010) state in their book that there lies a pipeline in most organizations that individuals follow as they progress through the levels of managerial responsibility. The pipeline chart illustrated below depicts the progression of management roles.

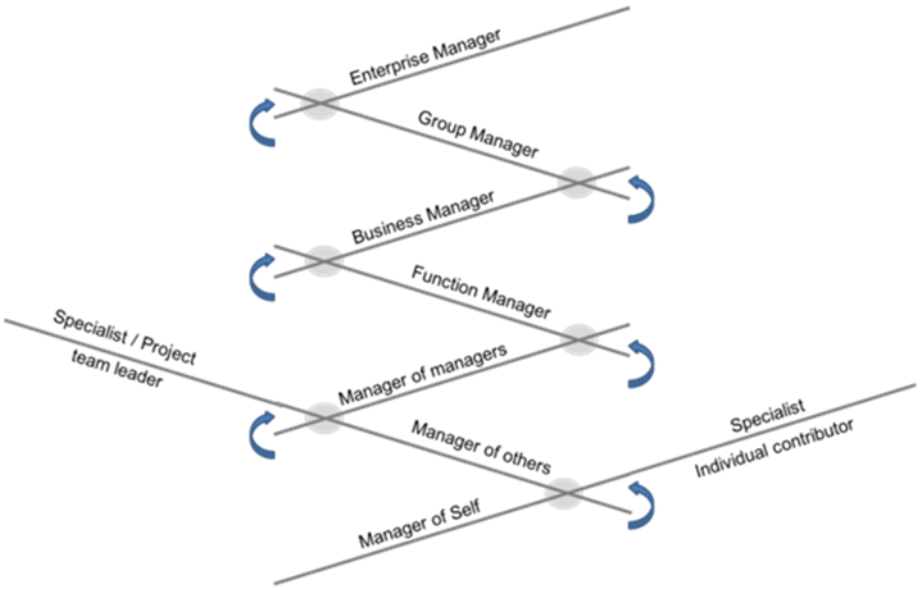


Figure 1: Management Role Pipeline

Scientists new to the workforce typically fall into the first section of the pipeline. Their initial roles allow them to manage themselves and act as individual contributors, which falls in line with the classical scientific training. The roles designed for the technically oriented individuals exist at this level.

A candidate's first level of management role typically is that of team leader, where managing others may come into conflict with a scientific role. The individual is still performing some scientific tasks. However, key project and people management tasks become part of their daily routine. As evidence shows, the front line management employees have conflicts in many cases with the desire to still participate in technical tasks (Farr & Brazil, 2009; Goldberg, 2006; Liu et al., 2012). Without managerial training at this level, the job characteristics outlined by J.

Richard Hackman and Oldham (1976) that influence work motivations may suffer. The initial area of management, however, may become a parking lot for individuals that get the job done but don't stand out (Biddle & Roberts, 1994; Roberts, 1994). Counter-intuitively, high performing individuals at this level may be retained at this level to ensure empirical results for the organization. The "no one else can get it done like you," phenomena in organizations may constrain an individual and decrease job satisfaction over time in the role (Liu et al., 2012).

The second level of management along the pipeline laid out by Charan, Drotter, and Noel (2010) is the manager of managers. The role as defined by the organization at this level abstracts individuals from the daily activities of their functional teams. The requirement to entirely work through the action of others could be a barrier to success for scientists. The lack of fundamental managerial training, whether from mentorship programs or formal education may affect all of the job characteristics that influence work motivations (J. Richard Hackman & Oldham, 1980). If so, the effect on job satisfaction increases the risk of reducing perceived success by both the individual and the organization.

The discussed levels of the management pipeline are presumed to be the most susceptible to the effects of training (Charan et al., 2010). The movement to higher levels of management is unlikely without success at the first two levels of the pipeline. Pons (2015) supports the need for managerial training at these levels, and the changes in educational structure within the engineering community confirm the perceived need for training as engineers progress upward along the pipeline.

In the experience of this author, few scientifically oriented organizations provide management training tailored for technically oriented individuals and those that do seldom introduce appropriate skills training. The observation falls in line with several studies across four

decades revealing this is a persistent phenomenon (Bawdny, 1982; Bayton & Chapman, 1972; Goldberg, 2006; Mainiero, 1986). Scientists in these work environments find themselves responsible for acquiring training to develop and enhance their management skills. To obtain the needed skills, scientists may pursue the needed training on their own through activities such as professional associations, conferences, self-teaching, and formal education such as graduate-level coursework. The support for these endeavors by leadership or human resources management may or may not exists. Therefore, conflicting organizational expectations and employee efforts may occur, which could decrease overall job satisfaction.

Conflicting role expectations might be minimized by appropriately characterizing the elements of the specific role and the skills needed. This process would then inform the employee of the types of continuing education to pursue and incorporate the appropriate level of support from the organization to ensure success. The organization may also undertake the task of identifying job attributes that align with the individuals that are selected for advancement and develop job characteristics that would positively affect job satisfaction. The process of job design is a crucial element in the development of technically oriented individuals who become managers.

The literature supports that moving from a technical expert role into a management role is difficult because of the different required skills for efficient performance (Mainiero, 1986; Roberts & Biddle, 1994). For example, technical skills in data analysis and design are essential for technical professionals whereas interpersonal, communication skills, and decision-making skills are essential for management. Some scientists transition into management smoothly, but for others, it may be difficult given their skills, backgrounds, interests, and previous training.

Therefore, it is critical to focus on the role of training for scientists transitioning into management.

II.2 Importance of Managerial Training

As the evidence presented above indicates, scientists have training in the scientific method but not in the realm of business processes. Roberts (1994) discusses that scientists have a natural desire to solve interesting problems and might not develop the interpersonal skills needed to function in managerial roles. The movement of scientists and engineers in managerial roles could, therefore, reflect a misallocation of intellectual resources. The need for basic training in interpersonal skills is discussed by Siggia (1975) regarding the additional needs of analytical chemists. Siggia discusses the need for an analytical chemist to be a leader of teams whose members come from the domain of engineering and business. The critical element of his commentary is that chemists should be trained in the skills of interpersonal relationships to develop into managers of their laboratories and teams. Teaching the concept in a classical sense is not enough to impart these skills to an individual (Siggia, 1975). The article states that chemists who focus on the numbers or real laboratory experiments should have a separate track versus individuals that show potential in observing the total situation. Such individuals display the capability of delegating tasks and leadership skills such as the use of feedback to improve job and team performance.

It is possible, as a manager, that the delegation of tasks to accomplish organizational goals reduces the perceived level of self-determination. Individuals not trained in managerial skills may lack the interpersonal skills to delegate a task efficiently. These individuals may or may not be able to effectively give and receive feedback, thereby reducing job satisfaction for the team and consequently himself. Personal orientation, not coupled with informal or formal

training of scientists in managerial skills often means that those who move into management positions lack the skills necessary to be competent managers (Lea, 1991), which may hurt job satisfaction.

Allen and Van der Velden (2001) find in their study that mismatches in skills, education, and role hurt job satisfaction. The study finds that over education for a role is not as important as the mismatch in skills for a role. Individuals that have under-developed skills without training to address the gap suffer greater job dissatisfaction than individuals who are over-educated for a role. However, individuals overly educated for a role will become dissatisfied over a period if they cannot progress upward to roles that will utilize the full capacity of their education and develop their skills further. The concept falls in line with the comments above that scientists mismatched in managerial roles without managerial skill development will be less satisfied in their role.

The lack of literature on management training of applied scientists leaves researchers with the need to use analogs such as engineers as a reference. In New Zealand, professional engineering organizations have offered various leadership workshops for some years. Pons (2015) study of the need for managerial training in engineering undergraduate education shows that as members of the professional organizations move along their career path they recognize the need for undergraduate management training as being increasingly critical. The finding would align with the principles discussed previously by Charan et al. (2010) that as individuals move upward in the management pipeline management training becomes more crucial.

The lack of undergraduate management education in the physical science curriculum as discussed previously has led other institutions to begin to fill the gap. Professional societies and focus groups have developed introductions to management practices through workshops and

seminar series. Williams, Ahmed, Hanson, Peffers, and Sexton (2012) discuss the development of leadership training for mathematics, engineering, and science students at Rose-Hulman Institute of Technology. The use of workshops, situational role play, and leadership seminar series embrace the use of training versus formal education as a solution. Professional organizations such as the American Society of Mass Spectrometry and the Society of Forensic Toxicology offer short courses on project and lab management at their annual meetings.

An analog for the effectiveness of managerial training for individuals that are not inclined to leadership roles appears in the nursing profession. Curtis, Sheerin, and de Vries (2011) find in their study of British nurses that the effect of managerial training is highly impactful to the overall satisfaction of nurses as they progress from individual contributor to roles that fall upon the pipeline discussed above. Nurses who transition to management roles struggle in many of the same issues as scientists, but managerial training increased organizational effectiveness while improving job satisfaction.

Thus their study supports the F. Herzberg (1968) theory and builds upon the findings of Siggia (1975), Bayton and Chapman (1972), Liu et al. (2012) and Roberts (1994) that hygiene factors such as financial compensation only go so far in providing satisfaction to employees. Restructuring tasks and training of the individuals to fit roles is needed to accomplish organizational goals and to achieve longevity in tenure increase job satisfaction.

Job dissatisfaction is not only detrimental to the individual scientists; it may produce reactions that are detrimental to the achievement of the organization's goals. Knapp, Smith, and Sprinkle (2017) discussed in their study utilizing J. Richard Hackman and Oldham (1976) Job Characteristics Theory, the characteristics in correlation to employee turnover and perceived organizational support. Their study finds a correlation between all five core characteristics with

job satisfaction. However, only a perceived higher level of autonomy affected the rate of turnover in a significant way. Also, the study finds that when career paths are limited, organizations that support growth in skill variety and knowledge growth also increase their levels of employee retention. The retention of knowledge workers, such as scientists, is critical to organizational success primarily due to their intellectual capital and the high cost of organizational performance in replacing highly valued employees (Bawdny, 1982; Mainiero, 1986; Yitmen, 2011).

II.3 Job Characteristics Theory

The Job Characteristics Theory (J Richard Hackman & Oldham, 1974; J. Richard Hackman & Oldham, 1980) outlines the relationship between different characteristics of a role and the individual responses individuals have to their assigned collection of the task. The condition of their assigned tasks may predict the way that individuals are most satisfied in their roles. Five role conditions influence three different psychological states that lead to mutually beneficial outcomes for individuals and their organizations. J. Richard Hackman and Oldham (1980) define individual variables that act as a moderator of the relationship between role characteristics and the collective role outcomes. These variables are defined as follows:

> **Skill Variety**: the degree to which a job requires a variety of different activities in carrying the work, involving the use of some different skills and talents of a person.
>
> **Task Identity**: the degree to which the job requires completion of a whole, identifiable piece of work; that is, doing a job from beginning to end with a visible outcome.
>
> **Task Significance**: the degree to which the job has a substantial impact on the lives of other people, whether those people are in an immediate organization or the world at large.
>
> **Autonomy**: the degree to which job provides substantial freedom, independence and discretion to the individual in scheduling the work and in determining the procedure to be used in carrying it out.

> **Feedback**: the degree to which carrying out the work activities required by the job provides the individual with direct and precise information about the effectiveness of their performance.

Three individual psychological states are defined by (J. Richard Hackman & Oldham, 1980) and are utilized to describe the way an individual perceives their role characteristics: meaningfulness, accountability, and knowledge. Meaningfulness defines the level at which an individual perceives their work as worthwhile and valuable, as measured by the averaged values of skill variety, task identity, and task significance. Expressed personal responsibility reflects the level of accountability an individual feels for the assigned tasks measured by autonomy. The third psychological state is knowledge of the results of the individual's work and how adequately they are performing their jobs measured by feedback. All three of these states must be experienced positively to find satisfactory job outcomes or level of job satisfaction. If a negative perception occurs in any of these psychological states, the motivation and overall satisfaction are negatively affected.

J. Richard Hackman and Oldham (1976) describe three moderators that are reliant on individual characteristics that govern the effectiveness of how changes in job characteristics affect the psychological state. First are the knowledge and skills needed to perform the role. Second is the Growth Need Strength that governs the desire for personal and professional growth. Lastly, is the work context, which relates to Herzberg's (1966) hygiene factors, such as salary, job security, co-workers, and benefits (see Figure 2).

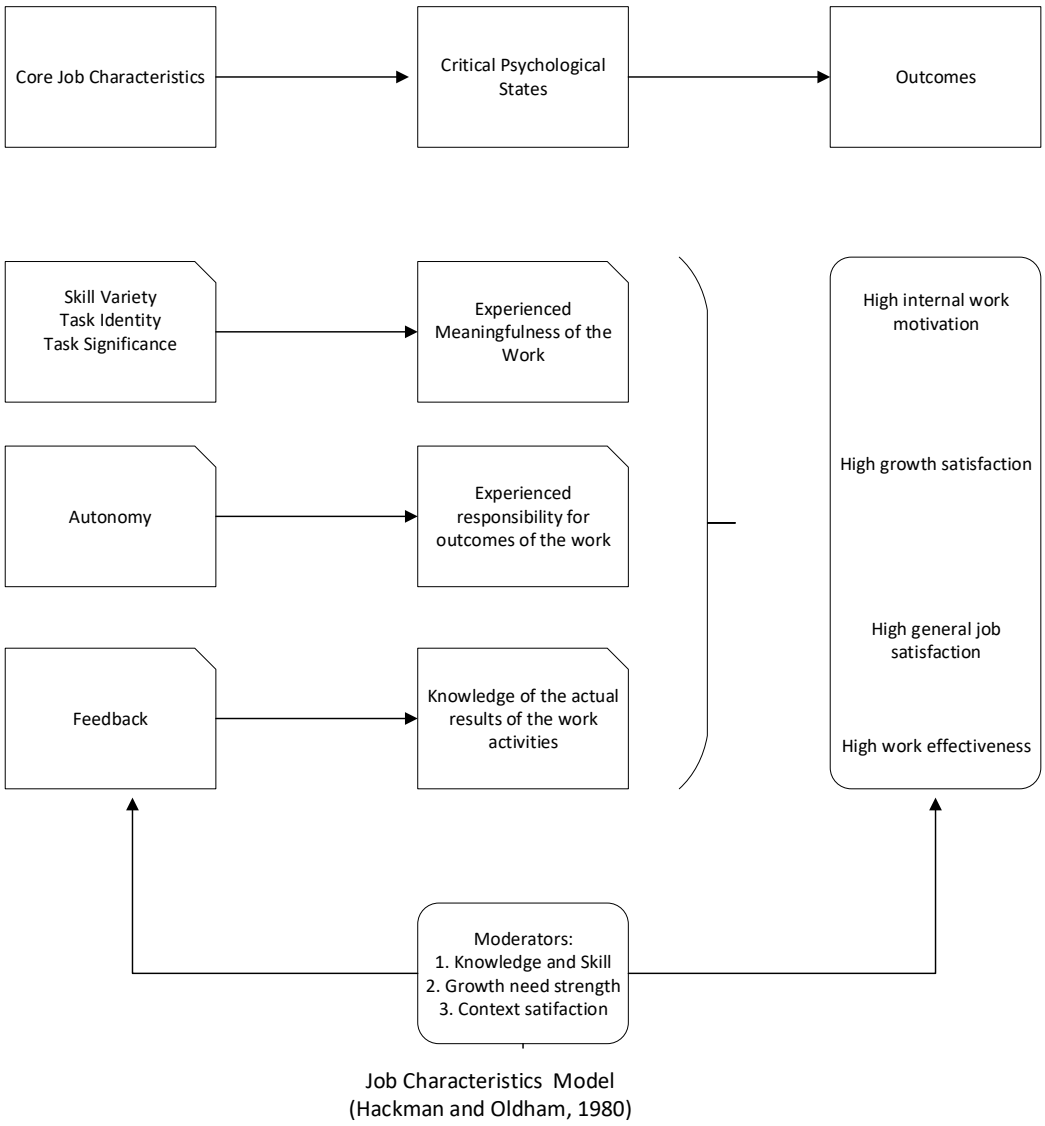


Figure 2 Job Characteristics Model

Hackman introduced the Job Diagnostic Survey, which allowed individuals to self-characterize their perceptions of their current role and modifications that could be made to obtain better job satisfaction. The primary constructs of the survey are utilized to identify Skill Variety (SV), Task Identity (TI), Task Significance (TS), Autonomy (AU), and Feedback (FB).

To apply Herzberg's theory to this study, scientists typically seek science-related careers to pursue their interests in science-related activities. They expect hygiene factors to be in place;

however, to enhance job satisfaction, other motivating factors should also be present. In the context of science-related professions, factors such as independence, intellectual challenge, and contribution to society, or the field of science, are crucial. However, as scientists are delegated management and leadership responsibilities, they will spend more time on management tasks, and their motivating factors may be compromised. Scientists with management responsibilities spend less time with science-related tasks such as research and development. It is possible that the challenges of a managerial role are not aligned with the personal interest of scientists. A scientist that does not find managerial activities as meaningful may no longer feel like they are contributing to society or the field of science, thus decreasing their motivating factors and job satisfaction.

Though the evidence presented supports the strength of Hackman and Oldham's Job Characteristics Theory, some literature questions support for the theory (Evans, Kiggundu, & House, 1979; Hogan & Martell, 1987). The primary criticisms of the Job Characteristics Theory and the use of the related survey are that the measurements are conducted on perceptions of individuals versus observed data. The argument against the use of perceptions versus real, measurable correlation to tasks does not provide precise objectivity of the tasks performed in a job.

However, Griffin (1983) stated that perceptions are a vital and viable measurement of a defined job and the way an organization designed the tasks associated with the job. A study of over two hundred published works in a meta-analysis of the theory by Fried and Ferris (1987) concluded that dismissing the perceptions and their correlation to job design would be inappropriate. The meta-analysis supports that the individual perception is a distinct and reliable measure of job design, motivational factors, and growth potential of individuals.

J. Richard Hackman and Oldham (1980) reviewed their original work with the following critique:

> "In sum, while there is support in the research literature for the Job Characteristics Model, it would be inappropriate to conclude that the model provides a complete picture of the motivational effects of job characteristics. Instead, the model is utilized as an aid in planning for changes in work systems. An especially important part of that planning process and one for which a conceptual model of some kind is almost essential is the pre-change diagnosis of a working system.

The Job Characteristics Theory (J. Richard Hackman & Oldham, 1976) expands on F. I. Herzberg (1966), and Maslow (1943) works to refine how certain aspects held in high regard by the scientist can be utilized to enrich their professional work environment. It is possible that when scientifically oriented individuals move into managerial or administrative roles, they may view their job as a series of repetitive tasks, as updating dashboards, performance reviews, and budgetary planning. These activities which the technically oriented employee might not perceive as meaningful affects their job satisfaction negatively, which causes them to reach back to their favorite technical tasks to fill the void (Goldberg, 2006).

II.4 Study Contributions

In summary, the transition of highly performing technical employees to front-line management roles without appropriate training is a pervasive problem as evidenced by the literature across several decades. Mainiero (1986) found in her study of sixty scientists and engineers from two research and development organizations that a significant number of scientists felt relegated to being a career technician. If an organization did not support the opportunity for individuals to self-select movement to a management role, job satisfaction suffers. Individuals that stay in the organization when they are not given opportunities to advance on an appropriate career path may become "checked out" without feeling responsibilities for

work outcomes and focus on external life factors (Krembs, 1983; Liu et al., 2012; Mainiero, 1986). The career then becomes merely a job. The insight highlights the importance of job design and the need to identify individuals motivated to lead beyond the laboratory (Bawdny, 1982). The mismatch between individual motivation and expectations of the organization can cause the same loss of intellectual capital as placing unprepared individuals into management roles.

The current body of knowledge utilizing Herzberg's Two-Factor Theory and Hackman and Oldham's Job Characteristics Theory as they relate to scientists is limited to a small set of published works on scientists and management job design. In the course of performing this literature search on scientists, many of the results were for computer scientists and knowledge workers. Only a slightly more extensive collection of literature reflects on the managerial training, job satisfaction, and role design in relation to engineers as an analog to scientist (M. Badawy, 1996; M. K. Badawy, 1971; Bailyn, 1982; Fitzgerald & Carlson, 1971; Holt & Ferber, 1964; Johnson & Sargeant, 1998; Liu et al., 2012; Mael, Waldman, & Mulqueen, 2001; Roberts, 1994). As discussed within Chapter I, there is a clear difference between the tasks of engineers and scientists in the applied applications, where a majority of the workforce lies (Xue & Larson, 2015). The pursuit of this study may help organizations understand the motivation of scientists, the impact of job design, and necessary training on job satisfaction. The knowledge should impact how organizations structure roles, tasks, and required training for scientists as they progress through the levels of management.

From theory, we know that workers have higher job satisfaction when skills and roles align. From the literature, we know that scientists and technically oriented individuals may experience higher levels of job satisfaction when they have skills and roles that align but the Job Characteristics Theory has not been applied to this group. The current literature suggests that

scientists do not follow the patterns described by Herzberg and Maslov, where promotion into management with higher levels of needs being met increases satisfaction, and consequently the job characteristics. We know that scientists may struggle with some aspects of managerial roles such as the interpersonal skills and delegation of tasks to others. There is evidence that in similar groups managerial training increases job satisfaction. Therefore, we are applying the Job Characteristics Theory to contribute to the knowledge of how the individual job characteristics are perceived between scientists in technical roles and scientists in managerial roles. We also expect to contribute to the knowledge of how the individual job characteristics influence job satisfaction when scientists in managerial positions receive managerial training. This application of theory generates the following research questions:

> **Research Question 1:** Does the promotion of scientists into management roles enhance the perception of job characteristics?
>
> **Research Question 2:** Does receiving managerial training alter the perceptions of job characteristics for all scientists, and specifically among scientists engaged in managerial activities?

These research questions will be tested using the Job Diagnostic Survey that was developed to be utilized with the Job Characteristics Theory specifically and has been utilized in over ten thousand peer-reviewed publications. The testing of the hypotheses in the next section were derived through the lens of the above theory.

III CHAPTER III - APPLYING THE JOB CHARACTERISTICS THEORY MODEL

III.1 Overview

It is possible that the structure of organizations that employ scientists and transitioned them into managerial roles do not consider employee characteristics when aligning individuals for management roles. The mismatch in expectations of both an individual that has transitioned to a managerial role and the organization may lead to an individual experiencing less job satisfaction. The Job Characteristics Theory model described the critical characteristics of Skill Variety (SV), Task Identity (TI), Task Significance (TS), Autonomy (AU), and Feedback (FB) and measured for variation. In this study, we apply the theory to two holistic groups, scientists that are currently in managerial roles and those who are in technical roles. Within each group, we control for whether or not the scientist has received managerial training to improve their understanding and mastery of the skills needed to manage budgets, people, and processes effectively. We use a modified Job Diagnostic Survey to measure the individual's perception of the attributes listed above, as well as the level of training support the organization maintains for the individuals in the management positions.

Figure 2 shows the two by two grid that allows for the easy visualization of the basis for each hypothesis. The upper row represents scientists who have managerial responsibilities compared to the lower row for scientists who are engaged in purely technical tasks. The left-hand column represents scientists who have received management training, compared to the right-hand column for scientists without such training. Thus, the upper left quadrant pertains to managers of all levels who have received managerial training. The upper right quadrant represents managers of all levels that have not received training. The lower left quadrant depicts

non-manager scientists that have received managerial training. The lower right quadrant represents non-manager scientists that have not received managerial training.

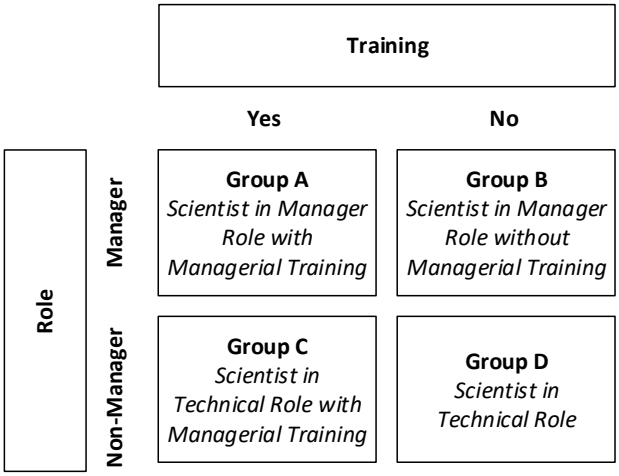


Figure 3- Role vs. Training Model

The literature review suggests that scientists with promotions into managerial roles are systematically different from other types of employees, but this has never been tested using Job Characteristics Theory. Therefore, because movement into a managerial role generally reflects a promotion and objectively expands job responsibilities, we state the hypotheses in the positive concerning the effect of role and training on the perception of job characteristics. That is, assuming that scientists are no different from any other group, one would expect those in managerial roles to experience higher levels of skill variety, task identity, task significance, autonomy and feedback and thus higher levels of job satisfaction. This statement of the hypotheses is consistent with general management theory but does not adjust according to the literature we find that accentuates the unique nature of scientists. Thus accepting our hypotheses for H1A through H5A means that the determinants of perception of the job characteristics among scientists are not systematically different from other groups. Accepting our hypotheses for H1B and C through H5B and C will mean that scientists respond like all employees to training.

Accepting H6 implies that controlling for job characteristics, the effect of assuming a role that generally reflects a promotion on job satisfaction for scientists is the same as for other studied groups. Finally, accepting H7 implies that controlling for the effect of training on job characteristics, the relationship between training for scientific managers and satisfaction is comparable to other studied groups.

III.2 Hypotheses

Each of the first five hypothesis aligns with a core job characteristic construct of the Job Characteristics Theory. The sixth hypothesis aligns with the overall outcome of the theory of Job Satisfaction, as it pertains to the study population. The seventh aligns with the overall outcome of the theory of Job Satisfaction as it pertains to scientists in managerial roles. We first will investigate the job characteristics in the order of occurrence in the Job Characteristics Model. Lastly, we will interrogate the general questions of job satisfaction as they pertain to scientists versus managers and overall effectiveness of managerial training on individuals in managerial roles.

III.2.1 *Job Characteristics*

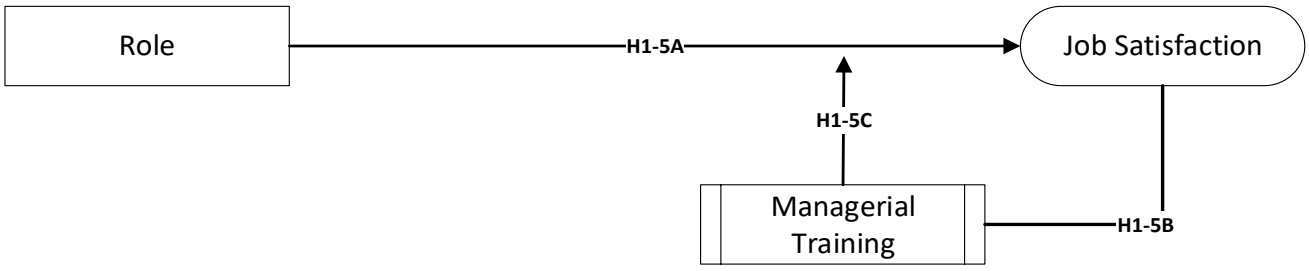


Figure 4- Model of Hypothesis 1-5 for Job Characteristics

III.2.2 *Job Characteristic - Skill Variety*

H1A: The degree of perception of Skill Variety a scientist experiences is positively related to occupying a management role in their organization.

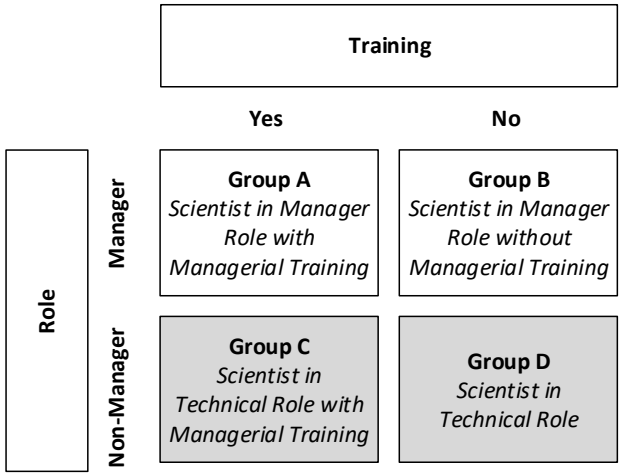


Figure 5-Group A&B versus Groups C&D on the effect of role on Task Identity

The hypothesis states a significant difference exists between individuals in scientific roles and individuals in managerial roles irrespective of managerial training as it relates to perceived Skill Variety. An assumption exists that Group A and B perceive higher Skill Variety than Group C and D. Groups A and B will perceive that they possess a requisite level of knowledge and skills that can be utilized to accomplish the tasks of their jobs, more readily than Groups C and D.

H1B: The degree of perception of Skill Variety a scientist experiences is positively related to receiving management training.

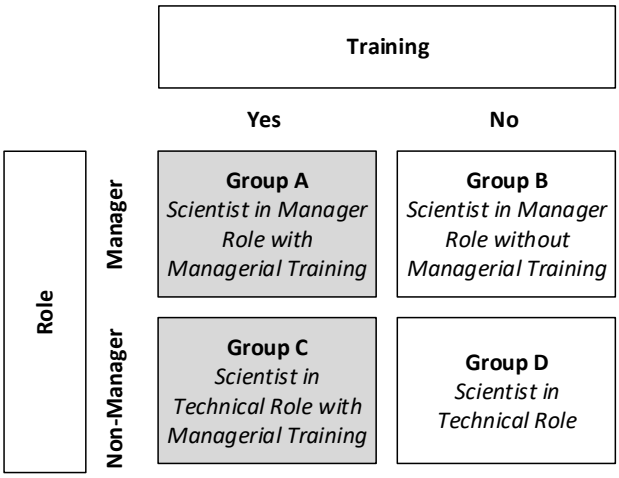


Figure 6- Group A&C versus Groups B&D on the effect of managerial on Skill Variety

The hypothesis states a significant difference exists between individuals that have received managerial training than individuals that have not received managerial training irrespective of role. Managerial training has a moderating effect on the perception of Skill Variety as individuals appreciate their tasks as essential to the success of the overall organization. Groups A and C will perceive at a higher level of Skill Variety than Groups B and D in that they possess the right combination of knowledge and skills to complete their tasks.

H1C: Among scientists with managerial roles the degree of perception of Skill Variety a scientist experiences is positively related to receiving management training.

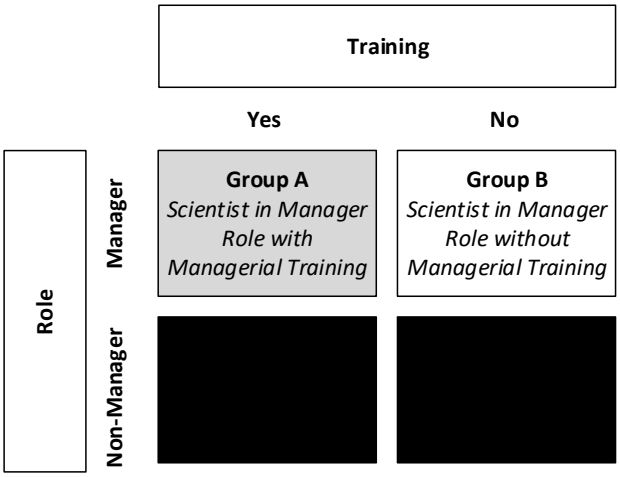


Figure 7-Comparison of Group A versus Group B on effects of Managerial Training to Job Satisfaction and Skill Variety

The hypothesis states that scientists in Group A, individuals in management roles with training will perceive a higher level of skill variety than those in Group B, individuals that have not received managerial training. Among individuals in management roles, receiving managerial training has a moderating effect on the perception of Skill Variety as individuals appreciate their tasks as essential to the success of the overall organization.

III.2.3 *Job Characteristic – Task Identity*

H2A: The degree of perception of Task Identity a scientist experiences is positively related to occupying a management role in their organization.

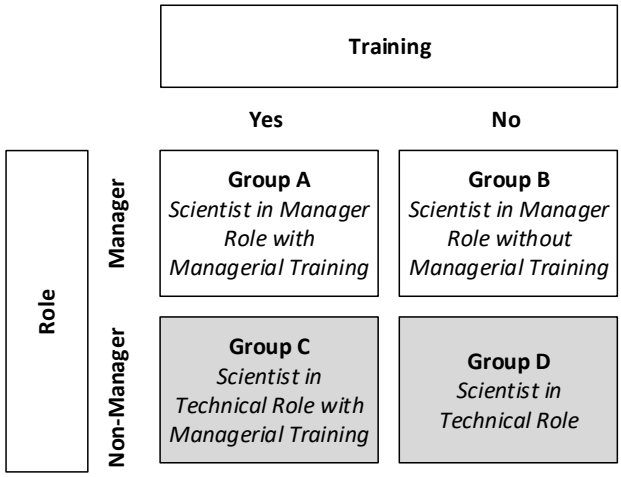


Figure 8-Group A&B versus Groups C&D on the effect of role on Task Identity

The hypothesis states a significant difference exists between individuals in scientific roles and individuals in managerial roles irrespective of managerial training as it relates to perceived Task Identity. An assumption exists that Group A and B perceive higher Task Identity than Group C and D. Groups A and B will perceive that they possess a requisite level of knowledge and skills that can be utilized to accomplish the tasks of their jobs, more readily than Groups C and D.

H2B: The degree of perception of Task Identity a scientist experiences is positively related to receiving management training.

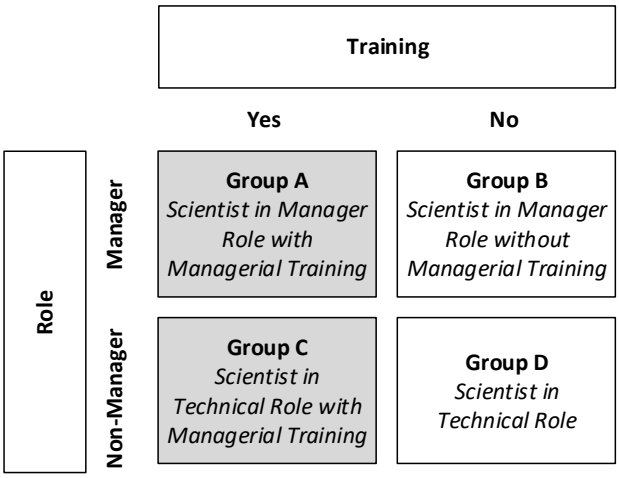


Figure 9- Group A&C versus Groups B&D on the effect of managerial on Skill Variety

The hypothesis states a significant difference exists between individuals that have received managerial training than individuals that have not received managerial training irrespective of role. Managerial training has a moderating effect on the perception of Task Identity as individuals appreciate their tasks as essential to the success of the overall organization. Groups A and C will perceive at a higher level of Task Identity than Groups B and D in that they possess the right combination of knowledge and skills to complete their tasks.

H2C: Among scientists with managerial roles the degree of perception of Task Identity a scientist experiences is positively related to receiving management training.

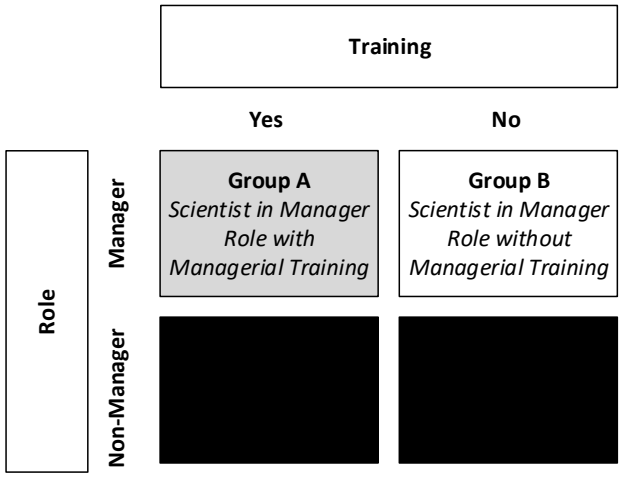


Figure 10-Comparison of Group A versus Group B on effects of Managerial Training to Job Satisfaction and Skill Variety

The hypothesis states that scientists in Group A, individuals in management roles with training will perceive a higher level of task identity than those in Group B, individuals that have not received managerial training. Among individuals in management roles, receiving managerial training has a moderating effect on the perception of task identity as individuals appreciate their tasks as essential to the success of the overall organization.

III.2.4 *Job Characteristic – Task Significance*

H3A: The degree of perception of Task Significance a scientist experiences is positively related to occupying a management role in their organization.

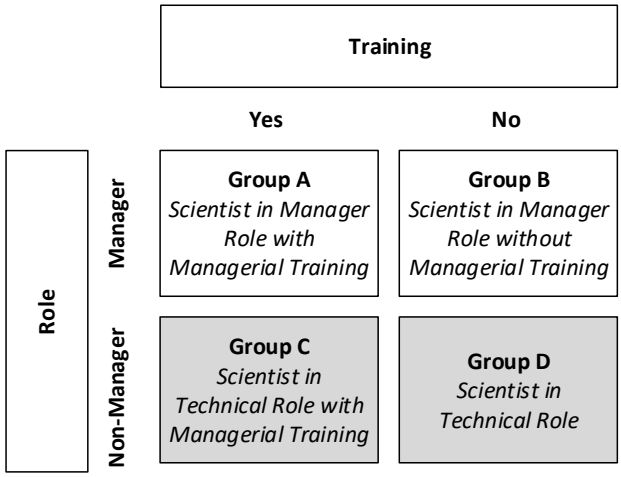


Figure 11-Group A&B versus Groups C&D on the effect of role on Task Identity

The hypothesis states a significant difference exists between individuals in scientific roles and individuals in managerial roles irrespective of managerial training as it relates to perceived Task Significance. An assumption exists that Group A and B perceive higher Task Significance than Group C and D. Groups A and B will perceive that they possess a requisite level of knowledge and skills that can be utilized to accomplish the tasks of their jobs, more readily than Groups C and D.

H3B: The degree of perception of Task Significance a scientist experiences is positively related to receiving management training.

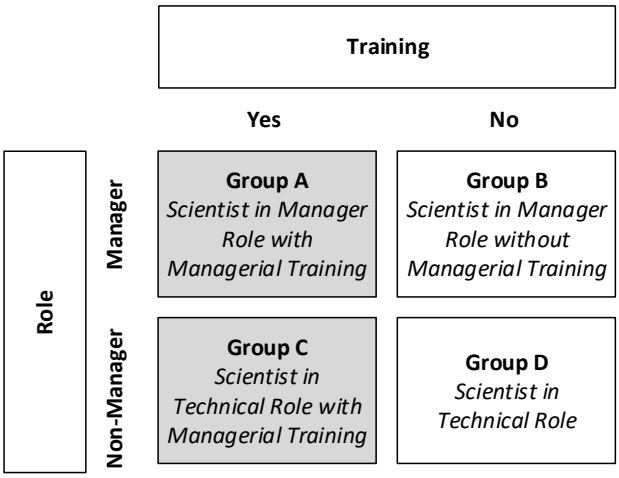


Figure 12- Group A&C versus Groups B&D on the effect of managerial on Skill Variety

The hypothesis states a significant difference exists between individuals that have received managerial training than individuals that have not received managerial training irrespective of role. Managerial training has a moderating effect on the perception of Task Significance as individuals appreciate their tasks as essential to the success of the overall organization. Groups A and C will perceive at a higher level of Task Significance than Groups B and D in that they possess the right combination of knowledge and skills to complete their tasks.

H3C: Among scientists with managerial roles the degree of perception of Task Significance a scientist experiences is positively related to receiving management training.

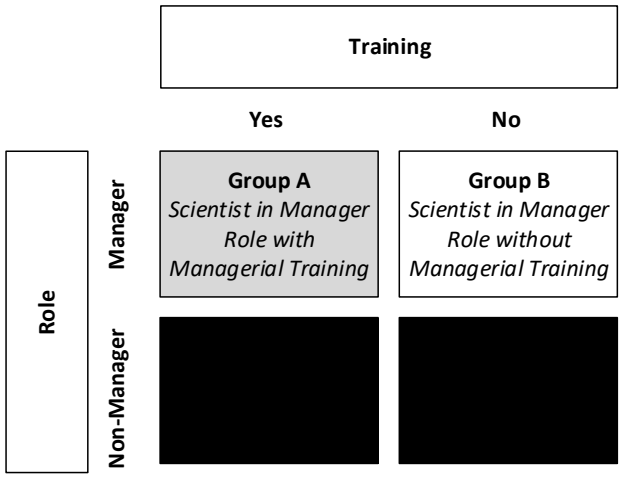


Figure 13-Comparison of Group A versus Group B on effects of Managerial Training to Job Satisfaction and Skill Variety

The hypothesis states that scientists in Group A, individuals in management roles with training will perceive a higher level of task significance than those in Group B, individuals that have not received managerial training. Among individuals in management roles, receiving managerial training has a moderating effect on the perception of Task Significance as individuals appreciate their tasks as essential to the success of the overall organization.

III.2.5 *Job Characteristic - Autonomy*

H4A: The degree of perception of Autonomy a scientist experiences is positively related to occupying a management role in their organization.

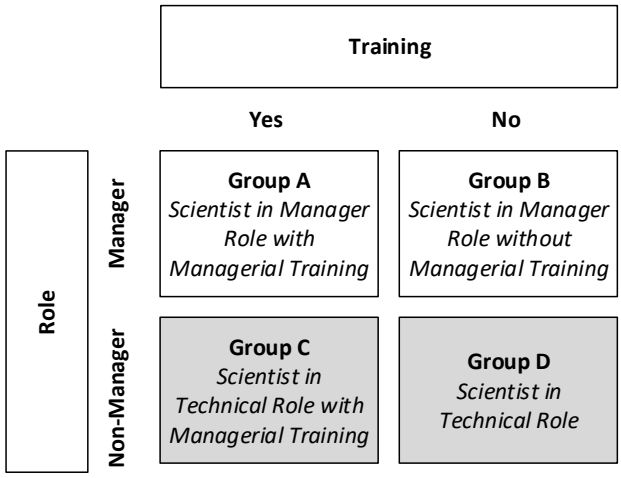


Figure 14-Group A&B versus Groups C&D on the effect of role on Task Identity

The hypothesis states a significant difference exists between individuals in scientific roles and individuals in managerial roles irrespective of managerial training as it relates to perceived Autonomy. An assumption exists that Group A and B perceive higher Autonomy than Group C and D. Groups A and B will perceive that they possess a requisite level of knowledge and skills that can be utilized to accomplish the tasks of their jobs, more readily than Groups C and D.

H4B: The degree of perception of Autonomy a scientist experiences is positively related to receiving management training.

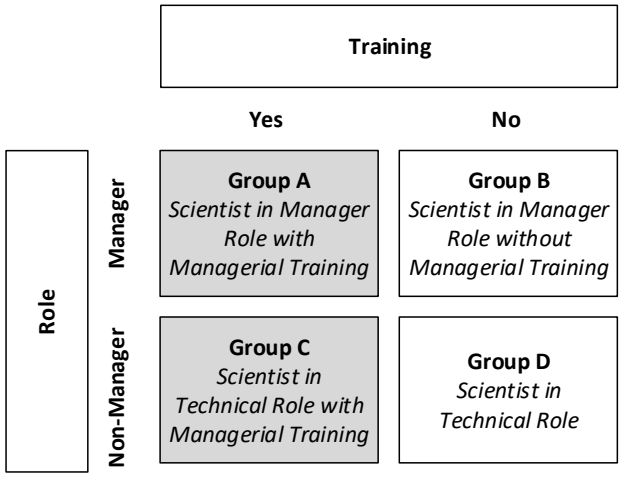


Figure 15- Group A&C versus Groups B&D on the effect of managerial on Skill Variety

The hypothesis states a significant difference exists between individuals that have received managerial training than individuals that have not received managerial training irrespective of role. Managerial training has a moderating effect on the perception of Autonomy as individuals appreciate their tasks as essential to the success of the overall organization. Groups A and C will perceive at a higher level of Autonomy than Groups B and D in that they possess the right combination of knowledge and skills to complete their tasks.

H4C: Among scientists with managerial roles the degree of perception of Autonomy a scientist experiences is positively related to receiving management training.

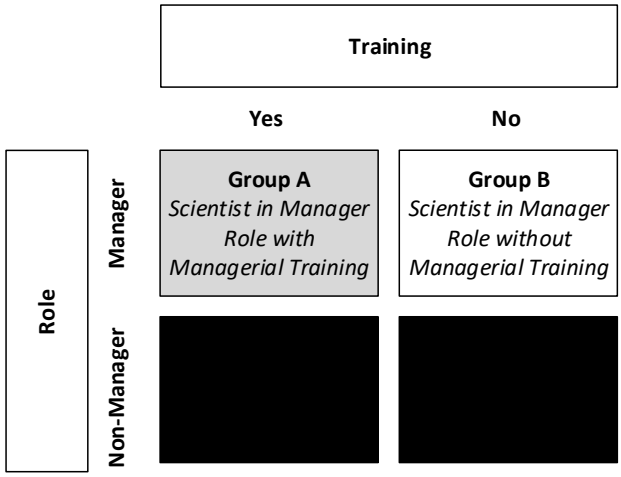


Figure 16-Comparison of Group A versus Group B on effects of Managerial Training to Job Satisfaction and Skill Variety

The hypothesis states that scientists in Group A, individuals in management roles with training will perceive a higher level of autonomy than those in Group B, individuals that have not received managerial training. Among individuals in management roles, receiving managerial training has a moderating effect on the perception of autonomy as individuals appreciate their tasks as essential to the success of the overall organization.

III.2.6 *Job Characteristic - Feedback*

H5A: The degree of perception of Feedback a scientist experiences is positively related to occupying a management role in their organization.

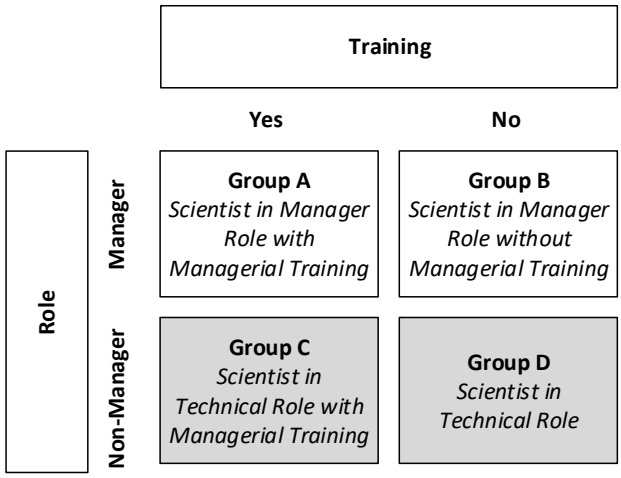


Figure 17-Group A&B versus Groups C&D on the effect of role on Task Identity

The hypothesis states a significant difference exists between individuals in scientific roles and individuals in managerial roles irrespective of managerial training as it relates to perceived Feedback. An assumption exists that Group A and B perceive higher Skill Variety than Group C and D. Groups A and B will perceive that they possess a requisite level of knowledge and skills that can be utilized to accomplish the tasks of their jobs, more readily than Groups C and D.

H5B: The degree of perception of Feedback a scientist experiences is positively related to receiving management training.

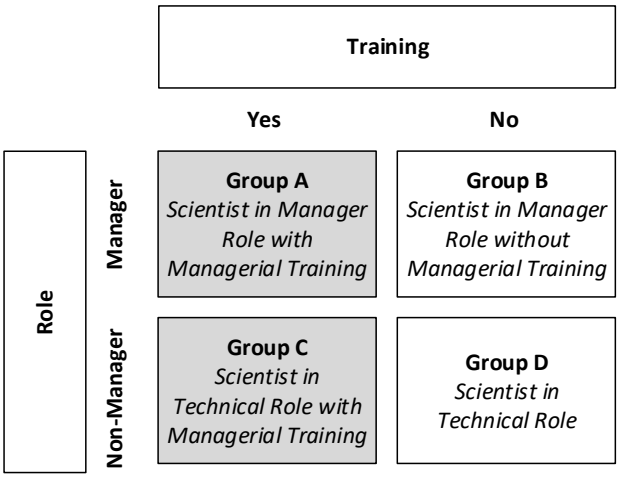


Figure 18- Group A&C versus Groups B&D on the effect of managerial on Skill Variety

The hypothesis states a significant difference exists between individuals that have received managerial training than individuals that have not received managerial training irrespective of role. Managerial training has a moderating effect on the perception of Feedback as individuals appreciate their tasks as essential to the success of the overall organization. Groups A and C will perceive at a higher level of Feedback than Groups B and D in that they possess the right combination of knowledge and skills to complete their tasks.

H5C: Among scientists with managerial roles the degree of perception of Feedback a scientist experiences is positively related to receiving management training.

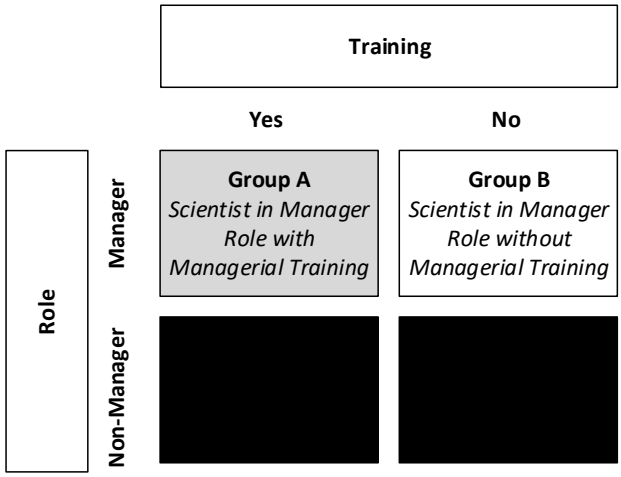


Figure 19-Comparison of Group A versus Group B on effects of Managerial Training to Job Satisfaction and Skill Variety

The hypothesis states that scientists in Group A, individuals in management roles with training will perceive a higher level of feedback than those in Group B, individuals that have not received managerial training. Among individuals in management roles, receiving managerial training has a moderating effect on the perception of feedback as individuals appreciate their tasks as essential to the success of the overall organization.

III.2.7 *Job Outcomes – Job Satisfaction*

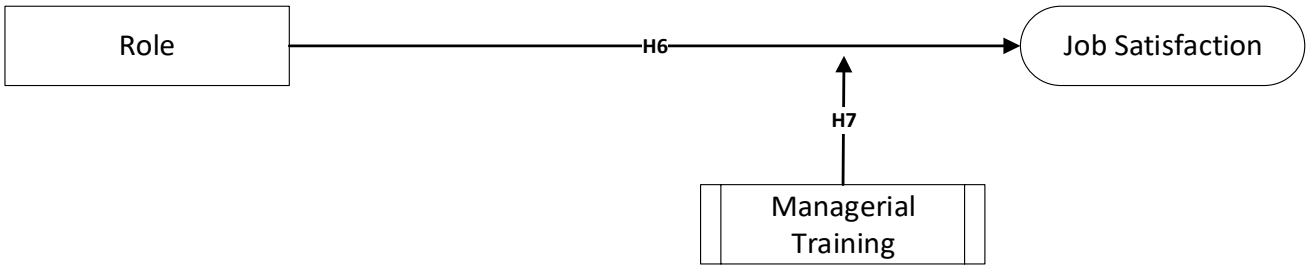


Figure 20- The effect of Role and Managerial Training on Job Satisfaction

H6: Overall Job Satisfaction is higher among scientists in managerial roles than among scientists in non-managerial roles

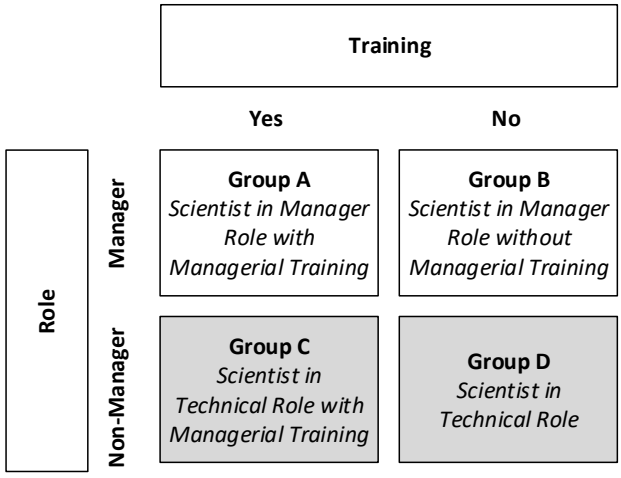


Figure 21- Group A&B versus Groups C&D on the effect of role on Overall Job Satisfaction

The hypothesis states that scientists who are fulfilling managerial roles in Groups C and D, independent of training, perceive a higher level of general job satisfaction than scientists that occupy technical roles in Groups A and B. While this is inconsistent with the literature that finds anecdotal evidence of dissatisfaction among scientists in managerial roles, it is consistent with the theory that these roles are a result of a promotion and reflect career success. As such, this

hypothesis tests the notion that scientists are just like all other employees and that scientists in such roles have chosen these promotions.

H7: Overall Job Satisfaction is positively perceived among scientists in managerial roles in who received managerial training than those that did not receive managerial training.

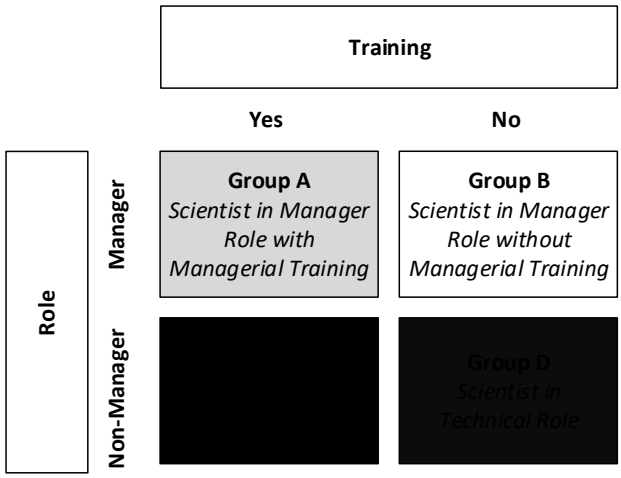


Figure 22- Group A versus Group B on the effect of training on overall job satisfaction

The hypothesis states that individuals in Group A having received managerial training and maintaining a managerial role perceive a higher level of job satisfaction than scientists that are managers without managerial training in Group B. Controlling for its effect on the perception of Job Characteristics, managerial training will have an observed effect on the expressed job satisfaction of scientists in managerial roles.

IV CHAPTER IV – METHODS AND DATA

IV.1 Data Sampling and Collection

In order to test the hypotheses above, we utilized the Job Diagnostic Survey, developed by Hackman and Oldham (1974), a non-copyrighted survey instrument administered without permission of the authors (Hackman and Oldham, 1980). The survey measured the perceptions of employees regarding the core job characteristics, critical psychological states, and personal/work outcomes. Validation of the instrument scales has been well established since the survey publication. A copy of the modified instrument used in this study appears in Appendix B.

IV.2 Data Collection

IV.2.1 *Population, Sample, and Subjects*

The study population consists of a compensated panel from the Qualtrics organization. The panel selection process included a recruitment regiment that was blind to the researcher, with guidance that participant selection consisted of a business to the business recruitment process limited to organizations providing scientific products and research.

The population is further constrained to individuals that were born between 1962 and 1992. The constraint provides individuals in the prime workforce age range, with recently degreed individuals and those still likely seeking advancement versus those concentrating efforts towards retirement. The sample is further constrained to individuals that have earned at least a Bachelor's degree in a scientific field of study that included biology, microbiology, chemistry, biochemistry, or physics. The constraint is consistent with hiring practices in the modern laboratory, where the pool of eligible individuals for advancement to managerial roles have met the minimum attainment requirement of a Bachelor's degree. Regulatory bodies, such as the Food and Drug Administration, control the requirement under the Code of Federal Regulations Part 21

or the Clinical Laboratory Improvement Amendments. A quota of a one to one split between managers and non-managers was placed on the body of the data to equally represent the division between scientists in managerial roles and scientists with non-managerial roles.

IV.3 Limitations

A narrow focus was used to conduct the study on the core job characteristics (J. Richard Hackman & Oldham, 1976) without the determinations of Motivation Potential Score or Growth Needs Strength. The survey was limited to a single direct and indirect measure of each of the core job characteristics. The analysis utilized direct measurement only to produce the results.

The published literature in the use of the Job Characteristics Theory is researching knowledge workers, and in particular, scientists is extremely limited. The choice of perceptions of the job characteristics as reflective or formative in nature is not well defined in the existing literature. Therefore, the study was conducted as reflective nature according to the construction of the hypotheses, and assuming that individuals select into their managerial positions with at least some anticipation of higher levels of satisfaction. The analysis of the results we performed with indicators in SmartPLS 3.0 set as reflective and tested for the alternative specification as formative. Specification as a formative model did not materially change the results.

The sample size was limited to two hundred and fifty-two observations, with participants limited to scientists working in the United States. Two conditions limited the respondents, both related to age. There were no individuals just entering the workforce nor were individuals in the last decade of their career considered. Utilizing the Qualtrics sample size calculation tool, it was determined that at a ninety-five percent confidence level with a five percent margin of error a minimum number of 119 scientists with managerial responsibilities would be needed.

The sample portion of scientists in managerial roles with managerial training was lower than expected. Utilizing the same tools, the number of respondents and the sample size reflects a confidence interval of twelve percent.

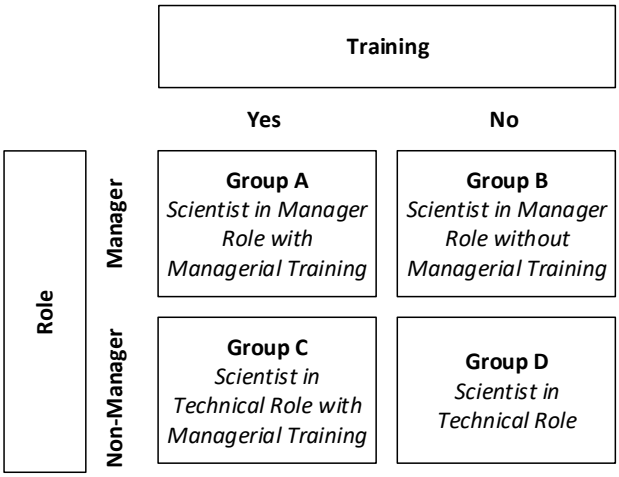
Overall, a larger sample size will be needed to overcome the limitations of the study and provide a more predictive model for practitioners.

Table 1- Summary Demographic Statistics of Study Observations

Demographic N=252	**# Total**	**# Manager Role**	**% Manager Role**	**# Non-Manager Role**	**% Non-Manager Role**
Total	252	131	52.0	121	48.0
Gender					
Male	83	53	40.5	30	24.8
Female	169	78	59.5	91	75.2
Scientific Degree					
Biology	132	64	48.9	68	56.2
Microbiology	14	4	3.1	10	8.3
Chemistry	80	51	38.9	29	24.0
Biochemistry	35	20	15.3	15	10.7
Physics	22	11	8.4	11	10.7
Engineering	13	9	6.9	4	3.3
Other	7	3	2.3	4	3.3
Highest Education Level					
Bachelor's	119	62	47.3	57	47.1
Masters	102	55	42	47	38.8
PhD	17	9	6.9	8	6.6
Professional Doctorate	16	8	6.1	8	6.1
MBA	9	5	3.8	4	3.3
Returned to Technical Role					
Yes	104	49	37.4	55	45.5
No	148	82	62.2	66	54.5

Demographic N=252	# Total	# Manager Role	% Manager Role	# Non-Manager Role	% Non-Manager Role
Management Experience (yrs)					
Less than 2	50	15	11.5	35	28.9
>2 to 5	57	33	25.5	24	19.8
>5 to 10	53	39	29.8	14	11.6
>10 to 15	29	24	18.3	5	4.1
>15 to 20	12	9	2.5	3	2.5
>20	15	10	7.6	5	4.1
None	33	0	0.0	33	27.3
Race					
White	185	101	77	84	69.4
Black	12	6	4.6	6	5.0
Native American	2	0	0.0	2	1.7
Asian	43	15	11.5	28	23.1
Pacific Islander	0	0	0.0	0	0.0
Other	10	9	6.9	1	0.8
Prefer not to answer (race/ethinicity)	8	2	1.5	6	5.0
Salary					
<$30k	14	5	3.8	9	7.4
>$30 to 50k	31	10	7.6	21	17.4
>$50 to 100k	104	52	39.7	52	43.0
>$100 to 150k	63	42	31.3	21	17.4
>$150	28	19	14.5	9	7.4
Prefer not to answer (income)	8	4	3.1	4	4.1
Managerial Training					
None	78	43	32.8	35	28.9
Mentorship Programs	43	38	29	15	12.4
Informal Courses	40	22	16.8	18	14.9
Formal Education	54	32	24.4	22	18.2
Graduate Certificates	36	23	17.6	13	10.7
On the job Training	73	42	32.1	31	25.6

IV.4 Independent Variables



- **Scientists in Managerial Roles:** Participants that responded "Yes" to question 42 in the instrument attached in Appendix A, where the respondent was asked, *"Do you currently manage or supervise other in your current role?"*
- **Scientists in Non-Managerial Roles:** Participants that responded "No" to question 42 in the instrument attached in Appendix A.
- **Scientists with Managerial Training:** The specification of managerial training comes from the answer to Question 67 of the instrument in Appendix A, which asks the respondent *"What if any preparation related to management have you obtained?"* The responses *"On the Job Training," "Mentorship Programs," "Informal Classes," "Formal Education"* and *"Graduate Certificate Courses"* have been coded to 1. The result of 1 is indicative of the participant receiving any training, regardless of form.
- **Scientists with No Managerial Training:** The specification of managerial training comes from the answer to Question 67 of the instrument in Appendix A. The responses of "None" have been coded to 0. The result of 0 is indicative of the participant not receiving managerial training.

IV.5 Dependent Variables

The table below identifies the constructs for each dependent variable, the survey question, and the coded response range utilized in the model construction.

Table 2- Description of indicators utilized in hypothesis testing.

Construct	Q#	Question	Coded Response = 1	Coded Response = 5
Skill Variety SV1	8	*"How much variety is there in your job?" To what extent does the job require you to do many different tasks that use your talents and skills?"*	Very Little	Very Much
Task Identity TI1	9	*"To what extent does your job involve doing a whole identifiable piece of your work? The job is a complete set of tasks from the beginning to the end of a project or is it a smaller part of a complete project, which is finished by other people?"*	Very Little	Very Much
Task Significance TS1	10	*"In general, how significant or important is your job? Do the results of your work significantly affect the well-being of other peoples lives?"*	Very Little	Very Much
TS2	23	*"I feel a great amount of responsibility for the work I do."*	Strongly Disagree	Strongly Agree
Autonomy AU1	6	"*To what extent does your job require you to work closely with other people? (i.e., either client or others from within your organization)"*	Very Little	Very Much
AU2	7	*"How much autonomy is there in your job? To what extent does your job permit you to decide on your own how to go about doing your work?"*	Very Little	Very Much
Feedback FB1	11	*"To what extent does the job itself provide you with information about your work performance? The job gives you clues along the way to let you know if the tasks are performed correctly, aside from co-worker feedback."*	Very Little	Very Much
FB2	12	*"In general, how much feedback is given by co-workers or supervisors to your performance of the job?"*	Very Little	Very Much
Job Satisfaction JS1	13	*"My overall satisfaction with my current role.",*	Extremely Dissatisfied	Extremely Satisfied
JS2	14	*"My overall satisfaction with my training/education opportunities in my current organization.",*	Extremely Dissatisfied	Extremely Satisfied
JS3	15	*"The training my organization provides to advance to the next level of responsibility",*	Extremely Dissatisfied	Extremely Satisfied
JS4	16	*"The organizational structure for the ability to choose between technical advancement and managerial roles",*	Extremely Dissatisfied	Extremely Satisfied
JS5	18	*"My overall satisfaction with my career advancement",*	Extremely Dissatisfied	Extremely Satisfied
JS6	19	*"My overall satisfaction with my organization",*	Extremely Dissatisfied	Extremely Satisfied
JS7	22	*"Generally speaking I'm satisfied with this job",*	Extremely Dissatisfied	Extremely Satisfied

Table 3- Descriptive Statistics of Dependent Variables Used in Hypothesis Testing

Construct	Q#	Question	Mean	Standard Deviation
Skill Variety SV1	8	*"How much variety is there in your job?" To what extent does the job require you to do many different tasks that use your talents and skills?"*	3.63	1.05
Task Identity TI1	9	*"To what extent does your job involve doing a whole identifiable piece of your work? The job is a complete set of tasks from the beginning to the end of a project or is it a smaller part of a complete project, which is finished by other people?"*	3.84	1.06
Task Significance TS1	10	*"In general, how significant or important is your job? Do the results of your work significantly affect the well-being of other peoples lives?"*	3.96	1.00
TS2	23	*"I feel a great amount of responsibility for the work I do."*	4.40	0.81
Autonomy AU1	6	"To what extent does your job require you to work closely with other people? (i.e., either client or others from within your organization)"	4.26	1.01
AU2	7	*"How much autonomy is there in your job? To what extent does your job permit you to decide on your own how to go about doing your work?"*	3.80	0.99
Feedback FB1	11	*"To what extent does the job itself provide you with information about your work performance? The job gives you clues along the way to let you know if the tasks are performed correctly, aside from co-worker feedback."*	3.60	1.00
FB2	12	*"In general, how much feedback is given by co-workers or supervisors to your performance of the job?"*	3.47	1.01
Job Satisfaction JS1	13	*"My overall satisfaction with my current role.",*	4.04	0.99
JS2	14	*"My overall satisfaction with my training/education opportunities in my current organization.",*	3.74	1.08
JS3	15	*"The training my organization provides to advance to the next level of responsibility",*	3.52	1.07
JS4	16	*"The organizational structure for the ability to choose between technical advancement and managerial roles",*	3.43	1.13
JS5	18	*"My overall satisfaction with my career advancement",*	3.79	1.09
JS6	19	*"My overall satisfaction with my organization",*	3.76	1.09
JS7	22	*"Generally speaking I'm satisfied with this job",*	4.06	0.95

IV.6 Control Variables

The control variables evaluated fall under the work context portion of the Job Characteristics Theory. Hackman and Oldham discuss that portions of an individual's

environment and background will influence the perceptions of the job characteristics and work outcomes which includes job satisfaction.

Each response to the demographic questions was re-coded to 1 as selected and 0 if the response was not selected. The included control variables included in each of the three models were determined for use by comparing the increase of r^2 values, p-values >0.150 and the increase in the average variance extraction (AVE). However, the AVE score was limited to a cutoff value range of 0.4 to 0.8 (Hair Jr, Hult, Ringle, and Sarstedt (2016); Henseler, Hubona, and Ray (2016), each evaluated demographic and corresponding significant responses were selected for each dependent variable. The tabularized model is found in Appendix C.

IV.7 Smart PLS Models

Multiple Regression utilizing SmartPLS version 3.0 was used to test the hypotheses. The constructs are subjected to linear regression analysis to observe the corresponding impact of each variable (beta value), r^2 explained variance and the level of significance (p-value) when exposed to treatment variables. SmartPLS allows for the observation of all latent variables in the single visual display.

The models for both the job characteristics and job satisfaction hypothesis testing were constructed with the demographic controls included in the regression logic. The models were first subjected to the PLS algorithm to determine the loadings of indicators onto each latent variable construct as shown within Appendix E. The indicators for the measures are deemed to be reflective in the hypothesis construction. Therefore, indicator elimination was performed. Any indicator that loaded with a factor of 0.7 or higher was automatically retained. The measurement of the constructs in this study was conducted in SmartPLS as reflective latent variables.

Workplace perceptions are reflections of the individual's employed situation (Subramaniama, Shamsudinb, & Alshuaibic, 2017). The Job Characteristics Method is discussed earlier to measure the perceptions of individuals in their work environment and that perceptions are important reflections of the workplace. The Job Diagnostic Survey is constructed so that individual elements of the job characteristics and psychological states may be removed without altering the result of the constructs. The survey as constructed by Hackman and Oldham has both a long and short form that allows for the constructs to be created by an altering number of indicators it is by definition reflective (Edwards, 2011)

Any indicator that scored between 0.4 and 0.7 was evaluated for significance utilizing the p-value of 0.05 as the cutoff criteria, before being retained or discarded. The final models used in the hypothesis testing are found below in Appendix E.

Table 4 - Final Outer Construct Loadings

Models	**TS1**	**FB1**	**FB2**	**JS1**	**JS2**	**JS4**	**JS5**	**JS6**	**JS7**	**TS2**	**AU1**	**AU2**	**SV 1**	**TI 1**
Series A	Q10	Q11	Q12	Q13	Q14	Q16	Q18	Q19	Q22	Q23	Q6	Q7	Q8	Q 9
Skill Variety H1													1	
Task Indentity_H2														1
Task Significance_H3	0.703									0.912				
Autonomy_H4											0.826	0.787		
Feedback_H5		0.827	0.857											
Job Satisfaction_H6 & H7				0.889	0.758	0.693	0.698	0.792	0.89					
Series B														
Skill Variety H1													1	
Task Indentity_H2														1
Task Significance_H3	0.767									0.879				
Autonomy_H4											0.801	0.813		
Feedback_H5		0.827	0.858											

Job Satisfaction_H6& H7				0.869	0.79	0.701	0.787	0.857	0.799					
Series C														
Skill Variety H1													1	
Task Indentity_H2														1
Task Significance_H3	0.729									0.978				
Autonomy_H4											0.953	0.861		
Feedback_H5		0.87	0.758											
Job Satisfaction_H6 & H7				0.755	0.809	0.863	0.731	0.765	0.736					

In Figure 22 is a simplified version of the Job Characteristics Model shown in Figure 2, as a guide to where the hypothesis fit in the overall model.

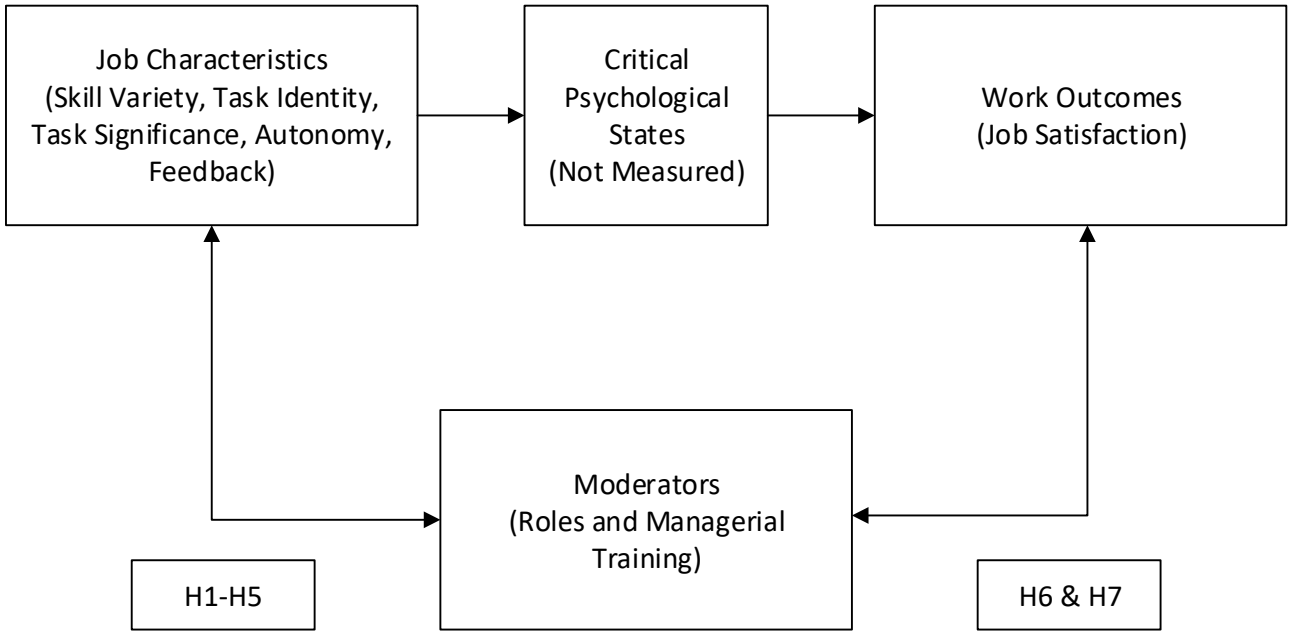


Figure 23 - Simplified Job Characteristics Model

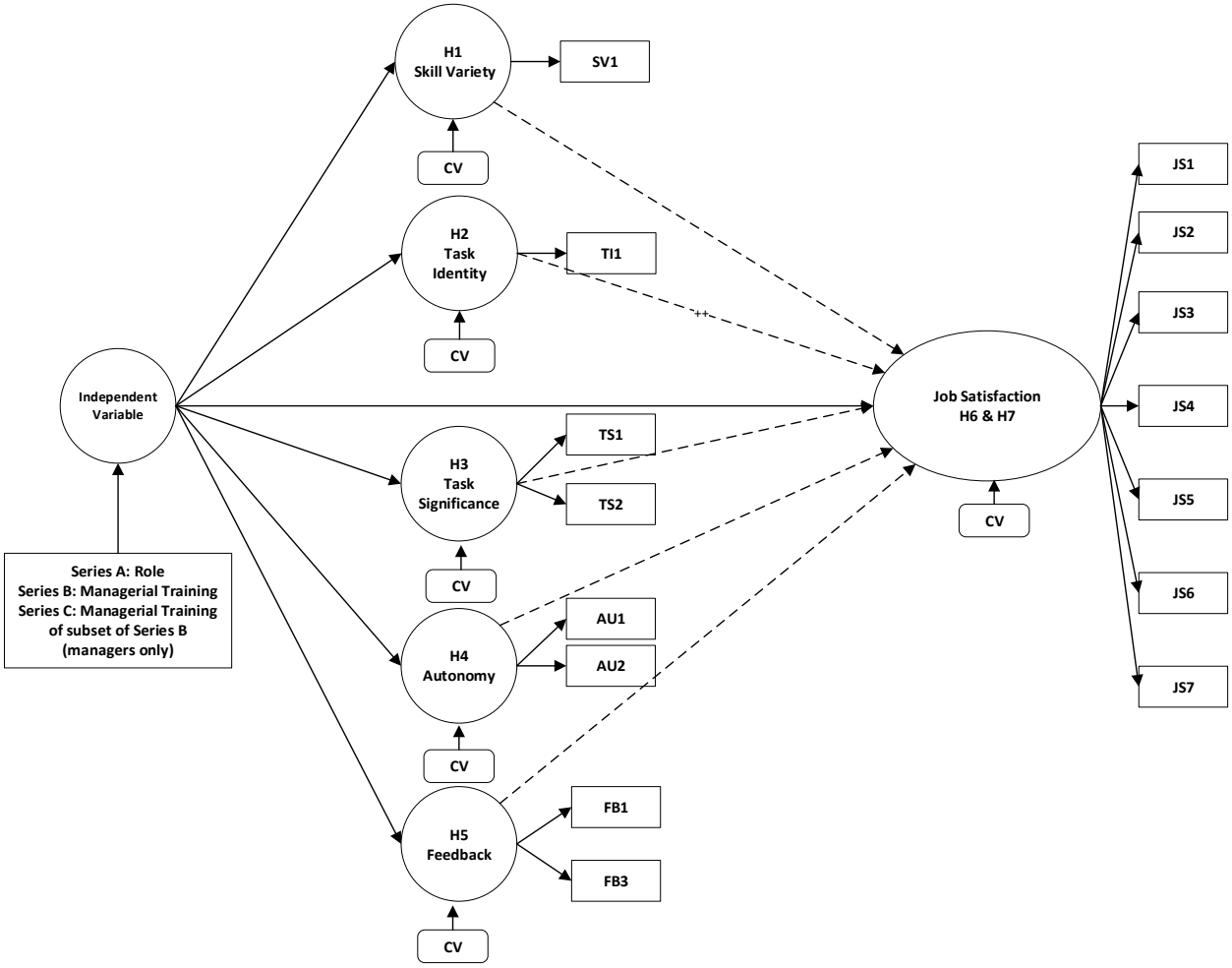


Figure 24 - Simplified SmartPLS 3.0 Model

In Figure 23, the Simplified SmartPLS 3.0 Model, the paths of analysis are shown as a solid line passing between the independent variable to the dependent variables. The dashed lines show indirect effects on job satisfaction. The indicators for each latent variable are shown in small rectangles with arrows showing they were set to be reflective in the analysis as discussed previously. The indicators are labeled according to the definitions in Table 3, Descriptive Statistics of Dependent Variables Used in Hypothesis Testing. The control variables are shown as rounded rectangles connected to the dependent variables. The full models for each series of

the hypothesis can be found in Appendix E, where the exact control variables for each dependent variable is assigned.

IV.8 Job Characteristics

The model for testing Hypothesis 1-5, the job characteristics, consisting of latent variables constructed from indicators that are reflective of the job characteristics. The dependent variables connect to the Job Characteristics and reveal the beta statistic and significance when linear regression analysis is performed. The model aligns with the theory in that the moderator's *Skill and Knowledge* (Managerial Training), *Work Context* (Role) and the combination of the two (RxT) impact the individual Job Characteristics and the outcomes (satisfaction).

IV.9 Job Satisfaction

The model utilized in Hypothesis 6 and 7 measures the relationship of the independent variables to job satisfaction. The indicators comprising the latent variable are reflective of the job satisfaction construct. The model includes the control variables as depicted in Figures 25 and 27, with tabular representations located in Appendix F. The model connects the job characteristics to job satisfaction as described in the Job Characteristics Theory, thereby estimating the effect of role and training on job satisfaction after controlling for effect on job characteristics.

IV.10 Collinearity

The model for each series of analysis was tested for collinearity of the latent variables by analysis of both the inner and outer models. SmartPLS 3.0 allows for the use of the Variance Inflation Factor (VIF) to be utilized as a measure of collinearity of the constructs and indicators. Hair (2006) prescribes that VIF values below 5 be acceptable in determining that no

collinearity exist. However, in recent discussions, the argument for a stricter interpretation of the VIF statistic has been made, suggesting a cut off of value 2.0 for the score (Nunally, 1978). As seen in tables 5 through 5 we observe that the values for all models depicted in Appendix D and E are well below Hair's recommendation.

Table 5- Hypothesis 1-5 Series A and Hypothesis 6 Inner Model Variance Inflation Factor Results

Series A	Autonomy H4	Feedback H5	Job Satisfaction H6	Skill Variety H1	Task Identity H2	Task Significance H3
Autonomy_H4			1.767			
Gender				1.246		
Race-White	1.042					
Race-Black					1.003	1.028
Race-Asian						1.043
Feedback_H4			1.417			
Field of Study-Biology		1.167		1.146		
Field of Study-Chemistry	1.182					
Field of Study-Engineering		1.092				
Field of Study-Microbiology		1.046	1.065	1.056		1.077
Field of Study-Physics		1.102				
IV - Role	1.198	1.031	1.303	1.043	1.005	1.118
Job Satisfaction_H6 & H7						
Salary $100-150k						1.082
Salary $30-50k	1.207			1.113		
Salary <$30k		1.061				
Salary >$150k	1.194					
Skill Variety_H1			1.765			
Task Indentity_H2			1.304			
Task Significance_H3			1.365			
Type of Degree - Bachelor	1.204			1.099		1.12
Type of Degree - PhD						1.149
Type of MGM training-Formal Ed	1.091	1.027	1.085			
Yrs MGM Experience - >10-15	1.2		1.275			
Yrs MGM Experience - >15-20			1.104			
Yrs MGM Experience - >20			1.2	1.102	1.009	
Yrs MGM Experience - >5-10	1.176		1.268			1.084

Table 6- Hypothesis 1-5 Series B Inner Model Variance Inflation Factor Results

Series B	Autonomy H4	Feedback H5	Job Satisfaction H6 & H7	Skill Variety H1	Task Identity H2	Task Significance H3
Autonomy_H4			1.772			
Gender				1.237		
Race-Black					1.007	1.031
Race-Asian						1.036
Feedback_H4			1.4			
Field of Study-Biology		1.188		1.15		
Field of Study-Chemistry	1.194					
Field of Study-Engineering		1.089				
Field of Study-Microbiology		1.044	1.062	1.057		1.08
Field of Study-Physics		1.104				
IV- Managerial Training	1.397	1.192	1.514	1.035	1.006	1.133
Salary $100-150k						1.085
Salary $30-50k	1.211			1.113		
Salary <$30k		1.059				
Salary >$150k	1.204					
Skill Variety_H1			1.759			
Task Indentity_H2			1.301			
Task Significance_H3			1.376			
Type of Degree - Bachelor	1.194			1.098		1.122
Type of Degree - PhD						1.158
Type of MGM training- Formal Ed	1.281	1.182	1.326			
Yrs MGM Experience - >10-15	1.179		1.272			
Yrs MGM Experience - >15-20			1.112			
Yrs MGM Experience - >20			1.211	1.101	1.006	
Yrs MGM Experience - >5-10	1.192		1.284			1.095

Table 7- Hypothesis 1-5 Series C and Hypothesis 7 Inner Model Variance Inflation Factor Results

Series C	Autonomy H4	Feedback H5	Job Satisfaction H7	Skill Variety H1	Task Identity H2	Task Significance H3
Autonomy_H4			1.429			
Feedback_H5			1.413			
Field of Study Biology				1.124		1.016
Field of Study engineering		1.025			1.013	
Field of Study physics		1.189	1.107	1.207	1.076	
IV – Managerial Training	1.307	1.223	1.313	1.217	1.099	1.195
Race white			1.101		1.054	1.017
Salary $50-100k	1.001		1.121	1.094		
Skill Variety_H1			1.461			
Task Indentity_H2			1.313			
Task Significance_H3			1.419			
Type of MGM Training -Grad Cert	1.309					
Type of MGM Training -OJT		1.337		1.331		1.183
Type of MGM Training -Formal Ed			1.253			
Yrs MGM Experience >10-15		1.061			1.103	
Yrs MGM Experience >15-20		1.032	1.143			
Yrs MGM Experience >2-5	1.003			1.036		
Yrs MGM Experience >20			1.141	1.073	1.038	

Table 8- Outer Model Variance Inflation Factor Results for Series

Indicator Survey Question #	Construct	Hypothesis 1-5 Series A and 6	Hypothesis 1-5 Series B	Hypothesis 1-5 Series C and 7
Q10	TS1	1.011	1.011	1.010
Q11	FB1	1.214	1.214	1.128
Q12	FB2	1.214	1.214	1.128
Q13	JS1	2.091	2.091	2.044
Q14	JS2	1.976	1.976	2.287
Q16	JS4	1.694	1.694	1.673
Q18	JS5	1.955	1.955	1.707
Q19	JS6	1.577	1.577	1.511
Q22	JS7	2.112	2.112	2.033
Q23	TS2	1.011	1.011	1.000
Q6	AU1	1.100	1.000	1.030
Q7	AU2	1.100	1.000	1.030
Q8	SV1	1.000	1.100	1.000
Q9	TI1	1.000	1.000	1.000

IV.11Model Validation

The model for testing the effects of the job characteristics on job satisfaction was validated utilizing the Blindfolding function of SmartPLS.

Blindfolding is a sample re-use technique, which removes data points and provides a predictive estimate of the impact on the original values. A value for the omission distance of eight is used in the validation of the model. An omission distance of eight indicates that every sixth data point of a variable's collected information will be removed in a single blindfolding round. The number of blindfolding rounds always equals the omission distance.

In the first blindfolding round, the procedure starts with the first data point and omits every 6th data point of a latent variable's indicators. Subsequently, the algorithm estimates the path model by using the remaining data points. The removed data represent missing values and are treated by mean value replacement. The results are then used to predict the omitted data points. The difference between the removed data points and the predicted ones calculate the prediction error. The Q^2 value is the result of the sum of the squared prediction errors. In the next iteration, the algorithm starts with the second data point, omits every 7th data point and continues as described before. After eight blindfolding rounds, every data point has been omitted and predicted. A Q^2 value larger than zero for a specific endogenous latent variable indicates the PLS path model has predictive relevance for this construct. Goodness of Fit model determination was not utilized, as PLS-SEM does not produce a reliable fit score that can distinguish between accurate and mis-specified models (Hair Jr et al., 2016).

Table 9, Blindfolding Results for Hypothesis 1-5 Sections A&B and Hypothesis 6, indicates that the Q^2 for the constructs utilizes to measure Hypothesis 1- 5 for sections A and B are positive and therefore a reliable predictor of the relationship between the independent and

dependent variables. Negative Q^2 Values would indicate that the relationship was not a good predictor (Hair Jr et al., 2016).

Table 9- Blindfolding Results for Hypothesis 1-5 Sections A&B and Hypothesis 6

	Construct	***SSO***	***SSE***	***Q² (=1-SSE/SSO)***	***Comment***
H1 - DV	*Skill Variety*	239.000	215.812	0.073	Reliable Predictor
H2 - DV	*Task Identity*	239.000	236.570	0.027	Reliable Predictor
H3 - DV	*Task Significance*	478.000	463.846	0.059	Reliable Predictor
H4 - DV	*Autonomy*	478.000	428.234	0.183	Reliable Predictor
H5 - DV	*Feedback*	478.000	464.175	0.062	Reliable Predictor
H6 - DV	*Job Satisfaction*	1,512.000	1,301.472	0.179	Reliable Predictor
IV	*Managers vs Scientists*	239.000	239.000		

Table 10, Blindfolding Results for Hypothesis 1-5 Sections C and Hypothesis 7, indicates that the Q^2 for the constructs utilizes to measure Hypothesis 1- 5 for sections C are positive and therefore a reliable predictor of the relationship between the independent and dependent variables. A separate validation for Section C was need as the hypothesis testing involved a subset of the responses utilized in sections A and B.

Table 10-Blindfolding Results for Hypothesis 1-5 Sections C and Hypothesis 7

	Construct	**SSO**	**SSE**	**Q² (=1-SSE/SSO)**	***Comment***
H1 - DV	*Skill Variety*	112.000	101.475	0.148	*Reliable Predictor*
H2 - DV	*Task Identity*	112.000	111.415	0.032	*Reliable Predictor*
H3 - DV	*Task Significance*	224.000	218.366	0.073	*Reliable Predictor*
H4 - DV	*Autonomy*	224.000	200.762	0.161	*Reliable Predictor*

H5 - DV	*Feedback*	224.000	214.165	0.097	*Reliable Predictor*
H7 - DV	Job Satisfaction	726.000	606.407	0.215	Reliable Predictor
IV	*Managers vs Scientists*	112.000	112.000		

IV.12 Validity

Construct validity testing of the models above yielded the following results. The cutoff of acceptability for Cronbach's Alpha is generally considered excellent when the value is equal to or above a value of 0.8 for latent variables, in primary areas of research values above 0.7 is deemed to be acceptable (Hair, Black, Babin, Anderson, & Tatham, 2006; Nunally, 1978). The cutoff value of the Average Variance Extracted results should be no higher than 0.8 for latent variables. Variables containing only one indicator will have a score or 1. Included in the analysis of the model discriminate validity is the use of the Monotrait-Heterotrait Ratio Table, which utilizes a multi-method and multi-trait matrix to analyze the correlations of the constructs when utilizing the sample normalization procedures in the bootstrapping process discussed below.

Table 11 shows that the latent variables utilized in testing hypothesis 1-6 all have an above 0.6 which is an acceptable cutoff value for reliability (Hair Jr et al., 2016).

Table 11-Construct Validity for Hypothesis 1-7

	Construct	***Cronbach's Alpha***	***rho_A***	***Composite Reliability***	***Average Variance Extracted (AVE)***
H1 - DV	*Skill Variety*	1.000	1.000	1.000	1.000
H2 - DV	*Task Identity*	1.000	1.000	1.000	1.000
H3 - DV	*Task Significance*	0.689	0.689	0.797	0.674
H4 - DV	*Autonomy*	0.764	0.764	0.789	0.651
H5 - DV	*Feedback*	0.697	0.697	0.803	0.710

H6 & H7	*Job Satisfaction*	0.809	0.809	0.915	0.693
IV	*Managers _vs_Scientist*	1.000	1.000	1.000	1.000

Appendix F illustrates the heterotrait to monotrait ratio relationships of the constructs utilized in the bootstrapping process for Hypothesis 1-7. All ratios for the model were found to be below the cutoff value of 1.0 as advised by Hair Jr et al. (2016).

IV.13Data Analysis Techniques

IV.14Bootstrapping Analysis

Partial Least Squares – Structural Equation Modeling (PLS-SEM) analysis does not assume that the data is normally distributed, which implies that parametric significance tests such as regression analysis cannot be applied to test whether coefficients such as outer loadings and path coefficients are significant. PLS-SEM relies on a nonparametric bootstrap procedure (Efron and Tibshirani, 1986; Davison and Hinkley, 1997) to test the significance of estimated path coefficients in the analysis.

The bootstrapping process creates subsamples from randomly drawn results from the original set of data and conducts replacement. The subsample is then used to estimate the path model. This process repeats until a large number of random subsamples has been created. The recommended amount from literature is 5000 subsamples, which is the value used in this study.

The PLS parameter estimates outer loadings and path coefficients from the subsamples are used to derive standard errors for the estimates. With this information, p-values are calculated to assess each estimate's significance. (Hair et al., 2017) The PLS Algorithm is utilized to produce the R^2, Adjusted R^2, Average Variance Extracted static and Variance Inflation Factor for values for the dependent variables in the regression analysis.

Hypothesis 1-5 measures the perception of the job characteristics. The dependent variables are Skill Variety, Task Identity, Task Significance, Autonomy, and Feedback respectively, as constructed in Appendix E. The independent variable in Section A is the scientists in managerial roles coded to a response of zero and scientists in non-managerial technical roles coded to a response of one. The independent variable in Section B and C is the reception of managerial training coded as zero and no managerial training as one. The difference between the two sections is population, as Section B is the entire population and Section C is the subset of managers only. Using SmartPLS ver 3.0, it is possible to estimate the effect of being in a managerial role on the perception of job characteristics for scientists. The dependent variables were treated with the control variables as depicted in Appendix F.

Hypothesis 6 measures the relationship between role and job satisfaction, as seen in the model as depicted in Appendix E. Using SmartPLS ver 3.0, it is possible to estimate the effect of being in a managerial role on the perception of job satisfaction for scientists. Utilizing the indirect effects method of SmartPLS ver. 3.0, a determination of the effects of each job characteristic is performed to determine the impact on job satisfaction. The dependent variables were treated with the control variables as depicted in Appendix F.

Hypothesis 7 measures the relationship between managerial training and job satisfaction as constructed in Appendix E. Using SmartPLS ver 3.0, it is possible to estimate the effect of being in a managerial role and receiving managerial training on the perception of job satisfaction for scientists in managerial roles. Utilizing the indirect effects method of SmartPLS ver 3.0, a determination of the effects of each job characteristic is performed to determine the impact on job satisfaction. The dependent variables were treated with the control variables as depicted in Appendix F.

IV.15Summarized Results

IV.16Study Population

The population of the study is found in the descriptive statistics in Table 1. The study collected 252 respondents to the Job Diagnostic Survey presented by Qualtrics to scientifically oriented businesses in a blind business to business collection model. The constraints of the study limited the collection to individuals in the prime workforce age range, with recently degreed individuals and those still likely seeking advancement versus those concentrating efforts towards retirement. The sample is further constrained to individuals that have earned at least a Bachelor's degree in a scientific field of study that included biology, microbiology, chemistry, biochemistry, or physics. The constraint is consistent with hiring practices in the modern laboratory, where the pool of eligible individuals for advancement to managerial roles have met the minimum attainment requirement of a Bachelor's degree. A quota of a one to one split between managers and non-managers was placed on the body of the data to equally represent the division between scientists in managerial roles and scientists with non-managerial roles.

IV.17Basic Demographic Results

The population of the study gathered by random recruitment of scientific personnel with at least a Bachelor's degree in the scientific fields of inquiry.

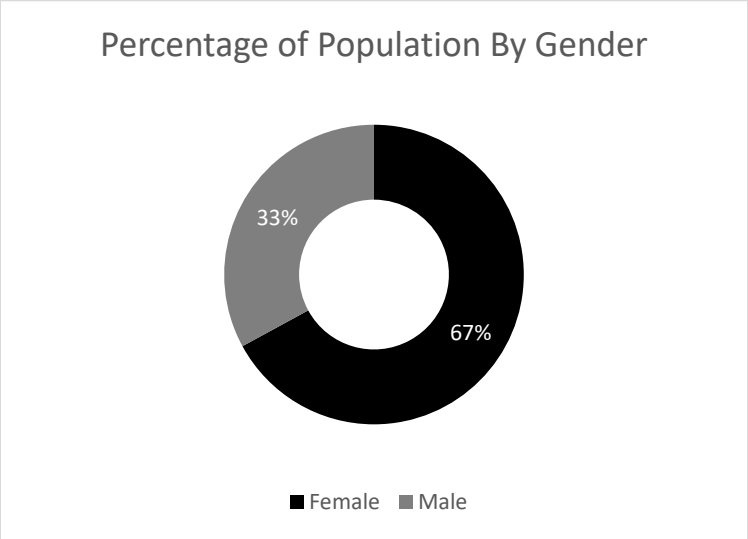


Figure 25- Study Population by Gender

The study follows the trends found in the NSF survey data on the population of race in the sciences in the United States. The population is comprised of a White majority of seventy-two percent, followed by Asian at seventeen percent as the two most significant components of the scientific community, with a five percent Black component, as Shown in Figure 27 below.

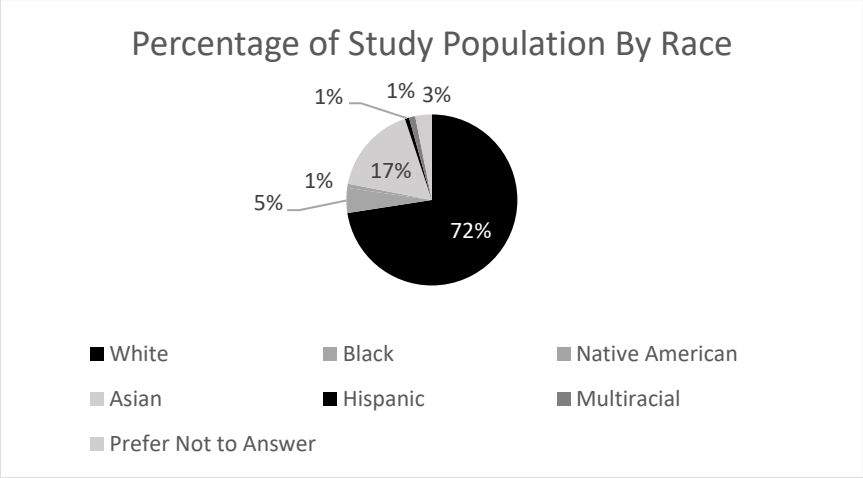


Figure 26- Study Population by Race

IV.18Education

The review of the scientific field of study indicated by participant response shows that the majority of the population received a biology degree. The study did allow for the participant to select multiple fields within the fields of discipline; however, only twenty-two percent of respondents replied to having received degrees from multiple fields of study. The results show that chemistry and microbiology follow in the order of frequency, as shown in Table 12. The finding roughly aligns with observations from the NSF 2015 survey.

Table 12- Fields of the study reported by respondents, including multiple disciplines

	Total Scientific Degrees Earned	**Managers**	**Non-Managers**
Biology	132	64	68
Microbiology	14	4	10
Chemistry	80	51	29
Biochemistry	35	20	15
Physics	24	11	11
Engineering	14	9	5
Other	7	3	4
Total	306	162	142

The results regarding educational attainment show the majority of participants primarily awarded a Bachelor's degree followed by a Master's degree, as shown in Table 13, Reported Highest Education Level. The survey did not differentiate between the awards of a Bachelor of Arts or Science in the study. The study shows an equal number of respondents

received a Ph.D. or professional doctorates such as a Medical Doctorate or Judicial Doctorate, with a small percentage having completed a Master of Business Administration.

Table 13- Reported Highest Education Level

Highest Education Level	Managers	Non-Managers
Bachelor's	62	57
Masters	55	47
PhD	9	8
Professional Doctorate	8	8
MBA	5	4

The review of salary distributions as displayed in Figure 30, reveals a normal distribution of salary for both scientists in technical roles and scientists in managerial roles. The majority of the population earn a salary between $50,000 and $100,000 annually. However, as shown below, assuming managerial responsibilities is associated with obtaining a higher salary (>$100,000) while those without managerial responsibilities are more likely to be among those with a lower salary.

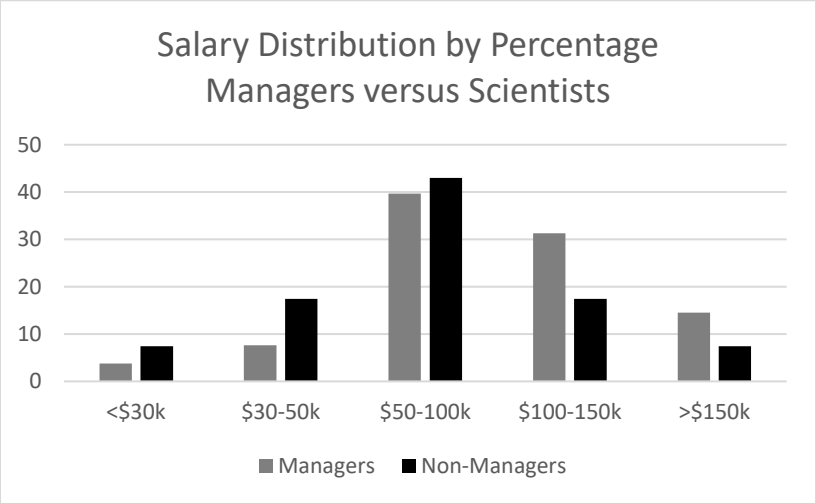


Figure 27- Study comparison of salary by manager vs. non-manager

IV.19 Scientists Returning to Technical Roles

The survey asked the respondents in Question 42, "Do you currently manage/supervise others in your role?". A "Yes" response indicates that the individual currently occupies a managerial role. A "No" response indicates that the individual occupies a non-managerial role. In answering Question 43 "Did you previously manage/supervise others and choose to return to a technical role?" A "Yes response indicated the individual previously occupied a managerial role and now occupied a non-managerial role. A "No" response indicates the individual has not supervised others. Individuals that answered "Yes" to Question 42 and "Yes" to Question 43 are deemed to have at one point earlier in their career to have occupied a managerial role and returned to a non-managerial role to return to a management role subsequently.

The results reveal that among participants currently in non-managerial roles, forty-six percent had prior managerial experience. Additionally, forty-two percent of individuals currently in managerial roles indicated that they had at some point in their career had returned to a non-managerial role.

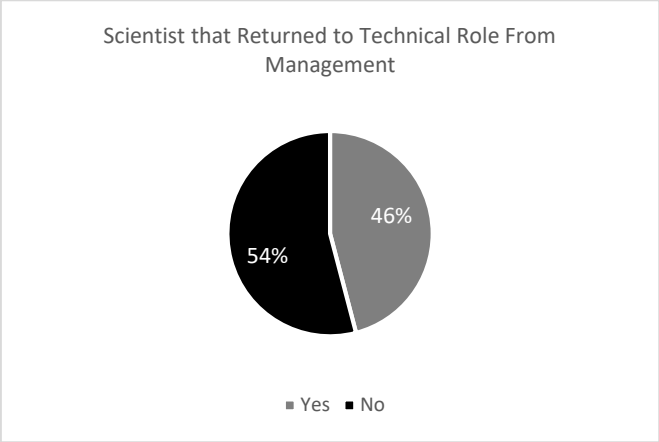


Figure 28- Scientist returned to a technical role by choice

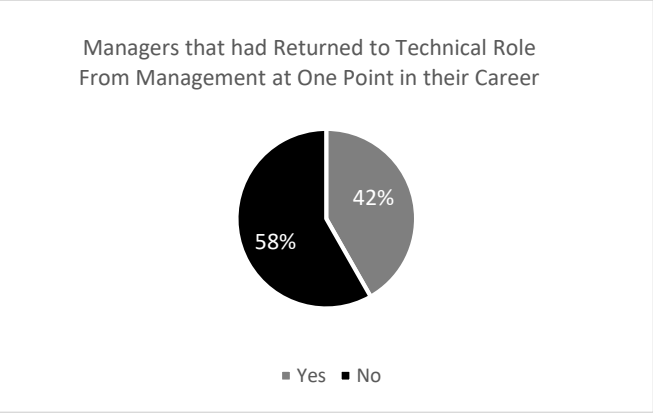


Figure 29- Managers that had previously returned to a technical role by choice

IV.20 Hypothesis Testing Results

Table 14 depicts the results of hypothesis testing results utilizing the models described previously. The support column indicated whether the hypothesis found support among the population and the comments column shows any unique findings as the related to the hypothesis.

Table 14 - Hypothesis Testing Results

	Testing Groups	Beta Statistic	R^2	Adjusted R^2	p-Value
	Hypothesis 1 – Job Characteristic: Skill Variety				
H1A	***Role Testing*** ***Scientist vs Managers***	-0.155**	0.218	0.181	0.050

	Testing Groups	Beta Statistic	R^2	Adjusted R^2	p-Value
H1B	***Training Testing With v W/O Management Training***	0.090	0.150	0.125	0.124
H1C	***Training Testing Only Managers***	0.314**	0.221	0.198	0.003
	Hypothesis 2 – Job Characteristic: Task Identity				
H2A	***Role Testing Scientist vs Managers***	-0.191**	0.121	0.098	0.040
H2B	***Training Testing With v W/O Management Training***	0.090	0.046	0.035	0.154
H2C	***Training Testing Only Managers***	0.613**	0.238	0.205	0.003
	Hypothesis 3 – Job Characteristic: Task Significance				
H3A	***Role Testing Scientist vs Managers***	-0.219**	0.207	0.183	0.049
H3B	***Training Testing With v W/O Management Training***	0.208**	0.198	0.177	0.000
H3C	***Training Testing Only Managers***	0.252**	0.215	0.191	0.000
	Hypothesis 4 – Job Characteristic: Autonomy				
H4A	***Role Testing Scientist vs Managers***	-0.244**	0.201	0.181	0.017
H4B	***Training Testing With v W/O Management Training***	0.144**	0.211	0.192	0.007
H4C	***Training Testing Only Managers***	0.124	0.114	0.098	0.233
	Hypothesis 5 – Job Characteristic: Feedback				
H5A	***Role Testing Scientist vs Managers***	-0.204**	0.196	0.178	0.002
H5B	***Training Testing With v W/O Management Training***	0.269**	0.121	0.103	0.000
H5C	***Training Testing Only Managers***	0.017	0.188	0.173	0.851
	Job Satisfaction Testing				
H 6	***Scientist vs Managers***	-0.063	0.394	0.372	0.314
H 7	***With vs. Without Management Training***	-0.079	0.252	0.221	0.384

***significance level=0.05*

Table 15- Hypothesis Testing Support Results

	Testing Groups	Support	Comment
Hypothesis 1 – Job Characteristic: Skill Variety			
H1A	***Role Testing Scientist vs. Managers***	Not Supported	The opposite direction of hypothesis
H1B	***Training Testing With v W/O Management Training***	Not Supported	No difference between groups
H1C	***Training Testing Only Managers***	Supported	None
Hypothesis 2 – Job Characteristic: Task Identity			
H2A	***Role Testing Scientist vs. Managers***	Not Supported	The opposite direction of hypothesis
H2B	***Training Testing With v W/O Management Training***	Not Supported	No difference between groups
H2C	***Training Testing Only Managers***	Supported	None
Hypothesis 3 – Job Characteristic: Task Significance			
H3A	***Role Testing Scientist vs. Managers***	Not Supported	The opposite direction of hypothesis
H3B	***Training Testing With v W/O Management Training***	Supported	None
H3C	***Training Testing Only Managers***	Supported	None
Hypothesis 4 – Job Characteristic: Autonomy			
H4A	***Role Testing Scientist vs. Managers***	Not Supported	The opposite direction of hypothesis
H4B	***Training Testing With v W/O Management Training***	Supported	None
H4C	***Training Testing Only Managers***	Not Supported	No difference between groups
Hypothesis 5 – Job Characteristic: Feedback			
H5A	***Role Testing Scientist vs. Managers***	Not Supported	The opposite direction of hypothesis
H5B	***Training Testing With v W/O Management Training***	Supported	None
H5C	***Training Testing Only Managers***	Not Supported	No difference between groups
Job Satisfaction Testing			
H 6	***Scientist vs. Managers***	Not Supported	No direct effect
H 7	***With vs. Without Management Training***	Not Supported	No direct effect

IV.21 H1: Effect of Role and Training on Skill Variety

Table 14, Hypothesis Testing Results reveals the results of the effects of the variables used to test the job characteristic Skill Variety. All the following analyses utilize linear regression analysis. It should be noted that while linear regression is utilized in SmartPLS, it does differ

from other analytical tools in that the measurement takes the entire path of the model into account if a hierarchy of constructs exists among the variables. The primary result is the beta statistic of the linear regression curve. A positive beta statistic indicates the perception of the job characteristic being measured is higher among scientists in managerial roles. The beta statistic is evaluated for its significance utilizing the P-value statistic. The r^2 value demonstrates the extent to which the model explains variance in the dependent variable.

The results contained in Table 14 show that the perception of the job characteristic of skill variety is perceived to be significantly different when the role is considered as stated in Hypothesis 1A, "*The degree of perception of Skill Variety a scientist experiences is positively related to occupying a management role in their organization."* The beta statistic is negative which is opposite of the hypothesis, where scientists in managerial roles perceive a significantly lower level of skill variety than individuals in technical roles. Thus, our results show that it is possible that scientists are unlike the general population in that the expansions of the role through promotion to include managerial responsibilities reduces their perception of the skill variety of the role. The hypothesis as stated deems the measurements to be reflective, when considering individuals that select to enter management have reflective perceptions. However, the results may be indicative of individuals that did not select to be in managerial roles but forced into the role by their organization. The observation occurs in all of the A series hypothesis.

Hypothesis 1B tests the perception of Skill Variety is increased among those receiving managerial training and finds that there is no difference for the general population. However, when testing the effect of training on perceptions of Skill Variety among those with managerial roles (Hypotheses 1C), the hypothesis is supported. Managerial training is associated with higher perceptions of Skill Variety among those with managerial responsibilities.

IV.22H2: Effect of Role and Training on Task Identity

Hypothesis H2A states "*The degree of perception of Task Identity a scientist experiences is positively related to occupying a management role in their organization,"* Tables 14 and 15 show that the beta statistic is negative and significant, opposite of the hypothesis. Therefore, scientists in technical roles perceive a significantly higher level of task identity than individuals in managerial roles. The results may show the same pattern as Hypothesis H1A that individuals that are in managerial roles that have not self-selected into occupying those roles then it may be indicative.

When managerial training is utilized in testing Hypothesis 2B, "*The degree of perception of Task Identity a scientist experiences is positively related to receiving management training*," there is no difference in the perceived task identity of the general population. The finding does not support the hypothesis. Hypothesis 2C states "*Among scientists with managerial roles the degree of perception of Task Identity a scientist experiences is positively related to receiving management training*." When the effect of training is tested on managers, the beta statistic follows the hypothesis and is significant. The result suggests that scientists in managerial roles with managerial training perceive a significantly higher level of task identity. The finding supports the hypothesis.

IV.23H3: Effect of Role and Training on Task Significance

Hypothesis 3A states "*The degree of perception of Task Significance a scientist experiences is positively related to occupying a management role in their organization,"* The results in Tables 14 and 15 show that the perception of the job characteristic of task significance is affected by role. However, the slope of the beta statistic is negative which is the opposite of the hypothesis. Scientists in managerial roles perceive a significantly lower level

of task identity than individuals in technical roles. As stated previously the A series results may be formative versus reflective and may be influenced by individuals for whom the predominant mechanisms for transitioning into management relates to the lack of alternative pathways for promotion or yielding to pressure from leadership.

When managerial training is utilized in testing Hypothesis 3B, "*The degree of perception of Task Significance a scientist experiences is positively related to receiving management training*," there is a higher level of perceived task significance in the general population of individuals who received managerial training. The finding supports the hypothesis. Hypothesis 2C states "*Among scientists with managerial roles the degree of perception of Task Identity a scientist experiences is positively related to receiving management training*." The results show that individuals that occupy a managerial role and receive managerial training perceive a higher level of task significance than managers that did not receive managerial training. The finding supports the hypothesis.

IV.24H4: Effect of Role and Training on Autonomy

Hypothesis 4A states, "*The degree of perception of Autonomy a scientist experiences is positively related to occupying a management role in their organization,"* Tables 14 and 15 show that the beta statistic is negative and significant, opposite of the hypothesis. Therefore, scientists in technical roles perceive a significantly higher level of autonomy than individuals in managerial roles. The results may show the same pattern as previous A series hypothesis in that individuals occupying managerial roles that have not self-selected into those roles may be indicative.

When managerial training is utilized in testing Hypothesis 4B, "*The degree of perception of Autonomy a scientist experiences is positively related to receiving management training*," the results show that individuals that receive managerial training had a higher level of perception of Autonomy in the general population. The finding supports the hypothesis. Hypothesis 4C states, "*Among scientists with managerial roles the degree of perception of Autonomy a scientist experiences is positively related to receiving management training*." The results reveal no significant differences between managers that received managerial training and those individuals that did not. The finding does not support the hypothesis.

IV.25H5: Effect of Role and Training on Feedback

Hypothesis 5A states, "*The degree of perception of Feedback a scientist experiences is positively related to occupying a management role in their organization*," Tables 14 and 15 show that the beta statistic is negative and significant, opposite of the hypothesis. As shown previously in the other hypothesis testing, scientists in technical roles perceive a significantly higher level of feedback than individuals in managerial roles.

When managerial training is utilized in testing Hypothesis 5B, "*The degree of perception of Feedback a scientist experiences is positively related to receiving management training,"* there is a significant difference in the direction of those who received managerial training in the perceived feedback of the general population. The results reveal a significantly higher level of the perception of feedback among individuals that received managerial training. The finding supports the hypothesis.

Hypothesis 5C states, "*Among scientists with managerial roles the degree of perception of Feedback a scientist experiences is positively related to receiving management training."* When the effect is tested on managers, the beta statistic follows the hypothesis and is significant.

The finding suggests that scientist that occupy managerial roles and received managerial training perceive a higher level of feedback. The finding supports the hypothesis.

IV.26H6 and H7: Effect of Role and Managerial Training on Job Satisfaction

Hypothesis 6 states "*Overall Job Satisfaction is higher among scientists in managerial roles than among scientists in non-managerial roles.*" The results located in Tables 14 and 15 suggest that role has no direct effect on job satisfaction. The finding does not support the hypothesis.

Hypothesis 7 states that "*Overall Job Satisfaction is positively perceived among scientists in managerial roles in who received managerial training than those that did not receive managerial training."* The findings do not support that managerial training has a direct effect on job satisfaction among managers.

However, Table 16 shows the Significant Indirect Effects of Job Characteristics on Job Satisfaction. We observe that job satisfaction is indirectly increased by the several but not all job characteristics.

Table 16 - Significant Indirect Effects of Job Characteristics on Job Satisfaction

	Job Characteristic	**Comment**	**Beta Statistic**	**p-Value**
H6	***Task Significance***		0.350	0.000
H6	***Autonomy***		0.243	0.049
H6	***Feedback***		0.343	0.022
H7	***Task Significance***		0.346	0.000
H7	***Autonomy***		0.243	0.049
H7	***Feedback***		0.343	0.022

Thus, the effects of role and training on the level of perception of the respective job characteristic translate into an indirect effect on Job Satisfaction. We can test this by estimating the effects of role, training, and the interaction on Job Satisfaction without controlling for the mediating job characteristics. These results, shown in Appendix C reveal a significant negative effect for role and a significant positive effect of training on satisfaction. However, our basic model shows that these effects are mediated by the job characteristics of Task Significance, Autonomy, and Feedback

V CHAPTER V – DISCUSSION

V.1 Reflection of Evidence to Literature

Bayton and Chapman (1972) discuss in the foundational work for this study that individuals that are technically oriented find greater satisfaction in performing technical tasks. Almost fifty years later this study concludes the same results. Their study section reviewing the motivating factors behind the individuals transitioning into management roles was not repeated in the current investigation. However, there is an insight into the realm of scientists at the National Institute of Health (NIH) and the effects of managerial training on individuals that had elected to make the change to management roles. Job Satisfaction of those that were in mentorship programs at NIH was higher than those individuals lacking any on-the-job training. In the current study, mentorship programs were included in the classification of managerial trained individuals. The results of the study did not show a significant direct relationship between managerial training and job satisfaction. The finding of this study follows the Job Characteristics Theory in that effect flows through the job characteristics model to job satisfaction.

The current investigation falls into the section of further research suggested by Bayton and Chapman to follow up on what effects job satisfaction of motivated individuals that have transitioned to managerial roles. The evidence that managerial training affects the perception of three of the five characteristics of those in managerial and scientific roles expands on their work by identifying sections of role construction that may be more impacted by managerial training. The finding that there is no difference between the groups in the perception of skill variety would indicate that each group perceives that they possess the adequate skills to perform the tasks assigned to their roles. An organization may focus efforts on the two areas

of greatest explained variance; task significance supports autonomy and feedback to increase job satisfaction of transitioning scientists to management roles.

Bayton and Chapman discussed that there were both engineers and scientists that won't fit into the management roles. These individuals by their nature are more suited to scientific inquiry. The results of the current study reveal that individuals with scientifically oriented roles perceive each of the five job characteristics significantly more. Following theory, the indirect effect of the job characteristics should influence job satisfaction. The results do not show a direct relationship between role and job satisfaction. The article by Roberts (1994) discusses that organizations utilizing scientists in managerial roles is a misallocation of resources. The current study supports some of Robert's findings but disputes other portions of the work. The article states that scientists are oriented psychologically to be investigative. The use of scientists in non-problem solving roles waste resources that organizations could utilize in furthering their product offerings or fundamental discoveries. As discussed previously, there were no significant differences found in scientists in or out of managerial roles in the area of job satisfaction once we controlled for perceived job characteristics. Exposing the scientists to managerial training does not equate to a higher perception of all job characteristics. The results show that training improved the perceived task significance, autonomy, and feedback. The increase of perception of these aspects of the role indirectly improves job satisfaction. These job characteristics translate through indirect effects into higher perceived job satisfaction. The findings reveal no difference in the perceptions of skill variety or task identity. The finding substantiates that some individuals thrive in technically oriented roles, regardless of exposure to managerial training. It is possible that exposure to managerial tasks and duties through education reinforces the individual's desire to remain in technically oriented roles, but increases

their appreciation of where they contribute to the overall success of the organization. Organizations should take into account the creation of dual-ladder career paths as Roberts (1994) and Liu et al. (2012) discuss.

However, the evidence that amongst scientists in managerial roles those with managerial training perceive three of five job characteristics significantly different from for those without managerial training is telling to the idea that nurturing managers indirectly effects job satisfaction. The positive of the effect of training is shown when the role is taken into account. The findings counter Roberts's statement that placing scientists in managerial roles is a misallocation of resources. Where organizations require scientists to lead in managerial roles because of the technical nature of the work, targeted training can ameliorate some of the reduction in job satisfaction found by Roberts. In hypothesis testing, groups exposed to managerial training showed a significant difference in the perception of skill variety. The observation is counter-intuitive given the managers receiving managerial training perceived the more significant amount of all job characteristics and job satisfaction as theory would expect.

The results as discussed above would support the article by Siggia (1974) who maintained that not every chemist should be in a leadership role. Chemists that thrive on producing analytical results and lab work should remain in technical roles, but those that show leadership potential should be given nurturing in the managerial arts if they chose to pursue that career opportunity. The evidence presented by Roberts and Biddle (1994) discuss the same principle. Individuals that self-select for managerial responsibilities need the support of their organizations to make the transition. It is possible that a large number of individuals who returned to technical from managerial roles found in this study can be attributed to the factors

Roberts and Biddle discuss. The lack of dual-ladder career paths channels individuals into management roles for which they are not suited to gain advancement in rank and reward.

This study also supports the study of Allen and Van der Velden (2001) where they found that a mismatch of skills was more detrimental than a mismatch of education on job satisfaction. The results of their study revealed that individuals are adaptable to roles outside of their previous educational pursuits if they were able to acquire skills that fit the currently occupied role. Skills may have an introduction to training but honed by practice within the daily task of the role occupied. The results of a significant difference between scientists in managerial roles and non-managerial roles in both the perception of all job characteristics, except skill variety and job satisfaction show that previous training in scientific inquiry allow them to view their skills as adequate for the roles occupied.

The evidence shows that skill variety and task identity are not affected by managerial training. The support for Allen and Van der Velden comes from the functioning practice of training in a role. The evidence that autonomy, task significance, and feedback were significantly different for the total population when taking managerial training into account supports that training alone does not enhance skills. The evidence would correlate back to the discussion by Siggia (1975) that once identified an individual needs nurturing in a leadership role to be successful. The mere exposure to management training does not increase the level of how the individuals perceive a greater sense of freedom in solving the problems associated with their role. In any case, the exposure to managerial training did not show a difference in the perception of skill variety. Each group reflects they have the adequate skills to perform the tasks associated with their role.

As the survey of educational institutions found no management coursework, in science curricula of the reviewed programs. The results show that individuals or organizations must develop managerial skills independently along with daily work tasks.

As discussed above, the percentages of both managers and non-managers that had returned to a technical role support the article by Pons (2015) where the engineering community in New Zealand and Australia realized that undergraduate managerial training was needed to ensure the success of the engineers. As engineers are commonly used as analogs to scientists in social science, this study would support a need for undergraduate exposure to the basics of management. The beginnings of some higher education institutions to host programs described by Williams et al. (2012) would show that the same concerns have arisen in the United States. The incidental finding in this study that forty-five percent of individuals returned to technical roles after occupying a management role support both of these articles that exposure to managerial arts are needed to inform early career scientists what they may expect in managerial roles. Training during the undergraduate period of education may reduce the return rate and increase job satisfaction of those moving into the roles. The anecdotal evidence witnessed by this author since the recession of 2008 is that more recently graduated scientists at the bachelor level of education are being asked by organizations in the applied sciences to manage teams of technicians and routine task laboratories. If this trends continuous, the needs that Pons discusses becomes more relevant. Bayton and Chapman (1972) suggest that the organization needs to fill a vacancy in management rapidly and the individual's need to advance in rank and pay are both substantial contributors to movement of scientists into managerial roles. However, in applied science organizations, roles for traditional scientists are being replaced by advanced scientific instrumentation and technicians. Scientists are placed in

the role of technical leadership because of their education and in some instances, a de facto managerial role. The undergraduate level exposure to the tasks associated with management could lighten the burden of the individual during transition or allow them to decline the opportunity intelligently.

V.2 Effects of Role on the Study Population

The role individuals occupy has a significant effect on their perception of job characteristics. The results discussed previously reveal that overall scientists that occupy non-managerial roles experience a significant difference in the perceptions of all five of the job characteristics.

The results do not support Hypothesis 1 through 5 section A that scientists in managerial roles would perceive the job characteristics significantly greater than scientists in non-managerial roles. The results may be inhibited by the nature of the hypothesis being reflective of the nature of the individual versus formative of the environment the scientist occupies. The lack of literature on the scientists as measured by the Job Characteristics Theory may have led to the misspecification of the study being performed as reflective versus actually being formative. Further investigations may be better suited to formative analysis if the predominant mechanisms for transitioning into management among scientists are related to the lack of alternative pathways for promotion or yielding to pressure from leadership. The results from this study suggest in fact that this may be the case. However, with the analysis being performed in both modes with little material change in the results, it is possible that the size and mixture of the population were too small.

Scientists have an inherent nature of inquisitiveness and roles that are constructed to maximize these traits would influence the perceptions of the job characteristics. Maslow (1943)

reflected in his hierarchy of needs pyramid the area of self-actualization to be paramount. As scientists, the usefulness of their nature of inquiry allows them to meet their self-fulfillment needs by solving complex problems. The results of this study do not support these fundamental principles that are foundations of the Job Characteristics Theory. Scientists that occupy roles that have expanded responsibility do not perceive any job characteristic higher than scientists in technical roles.

The analysis reveals that the role explained a large percentage of the variation and that those in scientific roles had the highest perceptions of task significance, autonomy, and feedback. Farr and Brazil (2009) in their findings on developmental skill for engineers find that feedback, both giving and receiving, is one of the most rewarding skills to develop.

The high perception of Autonomy by scientists in non-managerial roles would seem logical if the scientists only consider their autonomy in solving scientific problems; their scientific training prepares them for utilizing a variety of skills and tools to solve complex scientific problems. A scientist would seem to naturally experience a significant amount of Autonomy as they develop structures and processes that allow them to obtain answers to problems tasked by the organization. However, the types of problems managers are called upon to solve are different; these are adaptive problems without a clear answer or solution. While a scientist may have significant latitude to solve these problems, they do not value that type of autonomy as much as they value their autonomy to pursue scientific inquiry.

The results of the test of Hypothesis 6 where there was no difference between scientists in managerial roles and scientists in non-managerial roles in job satisfaction supports the Job Characteristics Theory in that work context affects job satisfaction through the job characteristics. The finding that scientists in non-managerial roles perceived more significant

levels of core job characteristics translated into higher levels of job satisfaction, through significant indirect effects in task significance, autonomy, and feedback consistent with the job characteristics theory. Unlike Kakar (2018) and Kumar (2011) who found autonomy to be the only significantly different job characteristic between groups, differences across groups were found for all 5 of the job characteristics in this study. Their results showed that for knowledge workers the Job Characteristics Theory might not be a proper lens to investigate these groups. In contrast, the results of the current study provide continued evidence of the validity of the JCT for science-related knowledge workers.

V.3 Effects of Managerial Training on the Study Population

The exposure of managerial training to scientist has a significant effect on their perception of task significance, autonomy, and feedback. The results support theory in that an increase of Skill and Knowledge, through managerial training, should positively affect the perception of the job characteristics. In contrast, we did not find that training had any effect on the perception of skill variety or task identity. The evidence supports the arguments of Biddle and Roberts (1994) in that work context and knowledge need to be applied together to assist individuals in the transition from scientists to managers. Since the population of the study is composed of more than half of the scientists in non-managerial roles the results would align with the expected results predicted by these works. It is possible that training may enhance the perception of task significance, autonomy, and feedback. However, skill variety and task identity are mindsets that may be less malleable to training. If we were to utilize the results of this study to peer into the individual's mindset, we should be able to find candidates for leadership as described in the study by Mael et al. (2001). Individuals that were exposed to

training and showed higher perceptions of skill variety and task identity may be candidates for managerial roles.

V.4 Effects of Managerial Training on Scientists in Managerial Roles

The exposure of managerial training to the scientist in managerial roles has a significant effect on their perception of three of the five job characteristics. The results support the Job Characteristics Theory in that the moderators of "Work Context" and "Skill and Knowledge" combined positively impact the perceptions of job characteristics, as well as, job satisfaction. Unlike managerial training's effect on the total population, scientists in managerial roles with managerial training experience a significant difference skill variety, task identity, and task significance. The characteristics are tied together in the Job Characteristics Model in a psychological state called Meaningfulness of Work. These three job characteristics have a significant indirect effect on job satisfaction. The results support with the findings of M. Badawy (1996) and Curtis et al. (2011) that both moderators together help transition technically oriented individuals satisfied in technical work to managerial roles with a higher level of satisfaction through the job characteristics that affect the deep feelings of success and purpose of one's work.

However, in the results of managers, the analysis revealed that forty-two percent had returned to a technical role at some point in their career from a management role. The percentage was discussed by Liu et al. (2012), and Mainiero (1986) in their studies were approximately thirty percent. The observation in this study may stem from the large female population. Wolfinger (2013) and England et al. (2016) discuss that women in science and highly technical fields often leave higher level positions during child-rearing years. When those individuals return to their profession, typically they must re-enter at the individual

contributor level and regain previous promotions. The population of the study being mostly female may be an influencing factor in this observation.

VI CHAPTER VI - CONCLUSION

The study was performed to answer fundamental questions behind roles that scientists in applied laboratories fulfill as illustrated through the presented hypotheses and the lens of the Job Characteristics Theory. Fundamentally, does role affect Job Satisfaction? From the evidence gathered in this study, the answer would be yes, but through the job characteristics and not as a direct influence. The influence of role on the overall job satisfaction of scientists flows through the job characteristics which is consistent with the Job Characteristics Theory. Scientists in technically oriented roles experience significantly higher perceptions of job satisfaction, and a majority of those have a significant indirect effect on job satisfaction than scientists in managerial roles. The results are consistent with the idea that the nature of scientists leads to satisfaction with the tasks of scientific inquiry, but counter-intuitive if one accepts the underlying assumptions that a higher salary, more control, and influence elevates satisfaction.

Secondly, if the above result is accurate, does managerial training affect job satisfaction of individuals that occupy managerial positions? The analysis of this sub-segment of the study population reveals the answer is yes. Those individuals in managerial roles that have obtained some form of managerial training experience higher levels of job satisfaction indirectly through job characteristics versus individuals in the same roles without receiving managerial training. Again, this result is logical, in that learning how to perform the tasks of a role should positively increase one's satisfaction with occupying that role.

Lastly, the study supports the use of the Job Characteristics Theory in the study of scientists. Previously the theory had only been utilized with partial success in studying knowledge workers which included scientists or engineers. The validation of the model and

the ensuing results supports that the theory is capable of answering a hypothesis about scientists as its unique group. As the Job Characteristics Model is the foundation for other theories that investigate with a finer grain the aspects of the five job characteristics, the study's unique use of the theory expands the JCM body of knowledge.

The evidence found in this study may be used in practice by organizations to identify opportunities to improve the construction of roles and training to enhance the job satisfaction of scientists that transition to managerial roles. The aspect of constructing training that will enhance the perceptions of the deficient job characteristics will allow organizations to focus resources on appropriate sections of the defined role. Also, organizations will be able to utilize the theory and survey to identify individuals that would better fit into managerial roles and those that would find more satisfaction in non-managerial roles. The results did support that certain individuals do not thrive in managerial roles and return to technical roles as predicted in the literature. This finding supports the ideas presented in prior research that a technical pathway for advancement is a proper practice for organizations to include in their role construction considerations.

The findings of this study lead to the need for additional research. The results not being highly predictive and of a limited number of participants leads to a need for further investigation. Also, the additional application of the full JCT model implies the need to study Growth Need Strength as it relates to Motivation Potential Score and the influence on the three psychological states for scientists and scientifically trained managers. While we identified the value of training, there is a need to understand further the types of skill development and knowledge transfer that most influences job satisfaction. Does this still hold in today's era of online learning? Do remote

mentorship programs work in the current workplace where the workforce is easily connected or is personal contact still the most influential?

Additional research is needed regarding the high propensity of individuals to leave a managerial role and return to a technical role. Did these individuals receive managerial training and then return? Alternatively, did the hygiene or motivator factors as discussed by Herzberg influence their return? Were these individuals experiencing the same level of satisfaction as those who had never left managerial roles? The correlating question from this line of thought would be why some of the respondents in the population were occupying technical roles but have not chosen to return from management roles. Were these individuals affected by the recession or by mergers within their industry?

The study furthers a line of inquiry into the determinants of job satisfaction among managers, whether managerial training influences job characteristics and general job satisfaction. Like Bayton and Chapman (1972) who found that mentorship programs in NASA and at the National Institute of Health were most effective in helping engineers and scientists make the transition to management, our findings point to the importance of training.

This study contributes to theory by showing the general applicability of the JCT to this population. It contributes to practice by showing the contributions of both role and training to the job characteristics and job satisfaction. Also, the analysis highlights many of the critical unanswered questions regarding the determinants of job satisfaction among scientists. The use of JCT may baseline an organization. However, expanded theories based on the JCT model may delve deeper into the causality of the findings. As secondary and higher education emphasizes the need to have a larger STEM-oriented workforce for supporting the businesses of the future, it is

necessary to improve our capability of assisting scientists in their choice of career paths and management potential.

APPENDICES

Appendix A: Higher Educational Degrees Offering Management Courses as Standard Curricula

	Chem	Bio	Physics	ME	EE	CE
Univ of Texas at Austin	✗	✗	✗	✓	✓	✓
Univ of Texas at Arlington	✗	✗	✗	✓	✓	✓
Univ of Texas at San Antonio	✗	✗	✗			
Univ of Houston	✗	✗	✗			
Texas A&M Univ	✗	✗	✗	✓	✓	✓
Texas A&M Univ at Galveston	✗	✗	✗	✓	✓	✓
Texas Tech Univ	✗	✗	✗			
Baylor Univ	✗	✗	✗			
Texas State Univ	✗	✗	✗			
Stephen F Austin State Univ	✗	✗	✗			
UCLA	✗	✗	✗			
UC San Diego	✗	✗	✗			
UC Berkley	✗	✗	✗			
UC Davis	✗	✗	✗	✓	✓	✓
Stanford Univ	✗	✗	✗	✓	✓	✓
UCSF	✗	✗	✗			
USC	✗	✗	✗			
Pepperdine Univ	✗	✗	✗			
Boston College	✗	✗	✗			
Boston Univ	✗	✗	✗			
Harvard Univ	✗	✗	✗			
Univ Mass	✗	✗	✗			
North Eastern Univ	✗	✗	✗			
MIT	✗	✗	✗	✓	✓	✓
Brown Univ	✗	✗	✗			

Appendix B: Job Diagnostic Survey

Start of Block: Block 6

Q60

Georgia State University

Informed Consent

Title: What job characteristics are affected by managerial training in scientists that are in management roles versus scientists that are in technical roles?

Principal Investigator: Patricia Ketsche

Student Principal Investigator: Jamie Humphries

Introduction and Key Information

You are invited to take part in a research study. It is up to you to decide if you would like to take part in the study.

The purpose of this study is to collect information on the effects of training on job characteristics.

Your role in the study will last 15 minutes.

You will be asked to do the following: answer a list of survey questions and submit the survey. Participating in this study will not expose you to any more risks than you would experience in a typical day.

This study is not designed to benefit you. Overall, we hope to gain information about how managerial training impacts job characteristics of scientifically and a technically trained individuals.

Purpose

The purpose of the study is to gather information pertaining to job characteristics and managerial training. You are invited to take part in this research study because you are have a bachelor's degree or higher in a scientific or technical field of study. A total of 1000 people will be invited to take part in this study.

Procedures

If you decide to take part, you will asked to answer an online survey only once, which will take approximately 15 minutes.

Future Research

Researchers will remove information that may identify you and may use your data for future research. If we do this, we will not ask for any additional consent for you.

Risks

In this study, you will not have any more risks than you would in a normal day of life.

Benefits

This study is not designed to benefit you. Overall, we hope to gain information about how managerial training impacts job characteristics of scientifically and a technically trained individuals.

Compensation

You will receive will receive an incentive based on the length of the survey, specific panelist profile and target acquisition difficulty. The specific type of rewards vary and may include cash, airline miles, gift cards, redeemable points, sweepstakes entrance and vouchers for

participating in this study and completing the survey.

Voluntary Participation and Withdrawal

You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time.

You may refuse to take part in the study or stop at any time, the respondent will not be compensated if they withdraw prior to completing the survey.

Confidentiality

The survey is being conducted by an external third party and we will not have access to any identifying personal information at Georgia State University.

We will keep the survey data private to the extent allowed by law. The following people and entities will have access to the de-identified information you provide:

• Patricia Ketsche

• Jamie Humphries

• GSU Institutional Review Board

• Office for Human Research Protection (OHRP)

We will use an identification number rather than your name on study records. The information you provide will be stored password- and firewall-protected computers.

When we present or publish the results of this study, we will not use your name or other information that may identify you.

Contact Information

Contact Jamie Humphries at 817-888-9900 or jhumphries9@student.gsu.edu

• If you have questions about the study or your part in it

• If you have questions, concerns, or complaints about the study

Contact the GSU Office of Human Research Protections at 404-413-3500 or irb@gsu.edu

• if you have questions about your rights as a research participant

• if you have questions, concerns, or complaints about the research

Consent

We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research, please check "Yes" below.

○ Yes (1)

○ No (2)

Skip To: End of Block If Georgia State University Informed Consent Title: What job characteristics are affected by manager... != Yes

End of Block: Block 6

Start of Block: Section 1

Q1 Were you born between 1962 and 1992?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Were you born between 1962 and 1992? != Yes

Q2 Have you earned a Bachelor degree or higher?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Have you earned a Bachelor degree or higher? != Yes

Q3 Select the field or fields in which you have earned a scientific degree or degrees:

- ☐ Biology (1)
- ☐ Microbiology (2)
- ☐ Chemistry (3)
- ☐ Biochemistry (4)
- ☐ Physics (5)
- ☐ Engineering (6)
- ☐ Not Applicable (7)

Skip To: End of Block If Select the field or fields in which you have earned a scientific degree or degrees: = Not Applicable

Q42 Do you currently manage/supervise others in your role?

- ○ Yes (1)
- ○ No (2)

Q43 If, No to previous question did you previously manage/supervise others and choose to return to a technical role?

- ○ Yes (1)
- ○ No (2)

Q44 Have you been afforded the opportunity to manage/supervise others in your career?

- ○ Yes (1)
- ○ No (2)

Q45 Have you sought management/supervisory roles in your career?

- ○ Yes (1)
- ○ No (2)

Q67 What if any preparation related to management have you obtained?

- [ ] None (1)
- [ ] Mentorship programs (3)
- [ ] Informal courses (4)
- [ ] Formal education - Additional Bachelors degree, MBA, etc.. (5)
- [ ] Graduate Certificate courses (6)
- [ ] On the Job Training (7)

Q59 How many years of managerial experience do you have?

- ○ Less than 2 (1)
- ○ 2 to 5 (2)
- ○ >5 to 10 (3)
- ○ >10 to 15 (4)
- ○ >15 to 20 (5)
- ○ >20 (6)
- ○ None (7)

End of Block: Section 1

Start of Block: Section 2

Q54 **The following questions ask you to provide information about the nature of your work responsibilities. Please consider all of your duties when responding to these questions.**

Q6 To what extent does your job require you to work closely with other people? (i.e. either client or others from within your organization) 1- Very little, dealing with others is not necessary to perform my job 3-Moderately dealing with others is necessary 5-Very much; dealing with others is absolutely essential to perform my job

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

Q7 How much autonomy is there in your job? To what extent does your job permit you to decide on your own how to go about doing your work

1-Very little, the job gives me almost no person say in how to perform my work 3-Moderately; many things are standardized and not under my control, but I can make some decisions on how to perform my work 5-Very much; The job gives me complete control on how to perform my work

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

Q8 To what extent does your job involve doing a whole identifiable piece of your work? The job is a complete set of tasks from the beginning to the end of a project or is it a smaller part of a complete project, which is finished by other people?

1-The job is only a small part of the total project or product 3-The job is a moderate sized "chunk" of the total project or product 5-The job involves the total project or product as its deliverable

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

Q9 How much variety is there in your job? To what extent does the job require you to do many different tasks that use your talents and skills? 1-Very little; the job requires me to do the same tasks over and over 3-Moderately dealing; Moderate Variety 5-Very much; the job requires me to perform a number of different tasks that utilizes my skills and experience

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

Q10 In general, how significant or important is your job? Do the results of your work significantly affect the well-being of other people lives? 1-Very little, the outcome of my work is unlikely to affect the lives of other people in a meaningful way 3-Moderately the outcome of my work is likely to affect the lives of other people in a meaningful way 5–Very much; the outcome of my work will absolutely to affect the lives of other people in a meaningful way

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

Q11 To what extent does the job itself provide you with information about your work performance? The job gives you clues along the way to let you know if the tasks are performed correctly, aside from co-worker feedback. 1-Very little, the tasks completion would not give me feedback 3-Moderately, some tasks in the routine give me feedback 5-Very much; the tasks are self-advising

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

Q12 In general, how much feedback is given by co-workers or supervisors to your performance of the job

1- Very little, I receive little or no feedback on my task completion 3-Moderately I receive some useful feedback from co-workers or supervisors on my job performance 5-Very much; I receive regular feedback on my performance

- ○ 1 (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5 (5)

End of Block: Section 2

Start of Block: Section 3

Q55 **The following questions ask you to provide information about the nature of your satisfaction with the characteristics of your organization and job. Please consider all of your duties when responding to these questions.**

Q13 My overall satisfaction with my current role.

- ○ Extremely satisfied (1)
- ○ Somewhat satisfied (2)
- ○ Neither satisfied nor dissatisfied (3)
- ○ Somewhat dissatisfied (4)
- ○ Extremely dissatisfied (5)

Q14 My overall satisfaction with my training/education opportunities in my current organization

- ○ Extremely satisfied (1)
- ○ Somewhat satisfied (2)
- ○ Neither satisfied nor dissatisfied (3)
- ○ Somewhat dissatisfied (4)
- ○ Extremely dissatisfied (5)

Q15 The training my organization provides to advance to the next level of responsibility

- Extremely satisfied (1)
- Somewhat satisfied (2)
- Neither satisfied nor dissatisfied (3)
- Somewhat dissatisfied (4)
- Extremely dissatisfied (5)

Q16 The organizational structure for the ability to choose between technical advancement and managerial roles

- Extremely satisfied (1)
- Somewhat satisfied (2)
- Neither satisfied nor dissatisfied (3)
- Somewhat dissatisfied (4)
- Extremely dissatisfied (5)

Q17 The level of organizationally supported preparation, before becoming a manager

- Extremely satisfied (1)
- Somewhat satisfied (2)
- Neither satisfied nor dissatisfied (3)
- Somewhat dissatisfied (4)
- Extremely dissatisfied (5)

Q18 My overall satisfaction with my career advancement

- Extremely satisfied (1)
- Somewhat satisfied (2)
- Neither satisfied nor dissatisfied (3)
- Somewhat dissatisfied (4)
- Extremely dissatisfied (5)

Q19 My overall satisfaction with my organization

- Extremely satisfied (1)
- Somewhat satisfied (2)
- Neither satisfied nor dissatisfied (3)
- Somewhat dissatisfied (4)
- Extremely dissatisfied (5)

Q20 My level of satisfaction with managing others

- Extremely satisfied (1)
- Somewhat satisfied (2)
- Neither satisfied nor dissatisfied (3)
- Somewhat dissatisfied (4)
- Extremely dissatisfied (5)
- Not Applicable (6)

End of Block: Section 3

Start of Block: Section 4

Q56 **The following questions ask you to provide information about your personal feelings about your job (the content of your work, not your organization or firm). Please consider all of your duties when responding to these questions**

Q21 My opinion of myself goes up when I do this job well

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

Q22 Generally speaking I’m satisfied with this job

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

Q23 I feel a great amount of responsibility for the work I do

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

Q24 I frequently look for advancement within the organization

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

Q25 I frequently look for opportunities outside of my current employer

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

Q26 I feel that I should take personal responsibility, good or bad, for the results of my work

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

Q27 I feel there is sufficient challenge in my job to invest in education to move to the next level

- Strongly agree (1)
- Somewhat agree (2)
- Neither agree nor disagree (3)
- Somewhat disagree (4)
- Strongly disagree (5)

End of Block: Section 4

Start of Block: Section 6

Q58 **The following questions ask you to provide information about what you would like in any job you would consider in the future. Please consider all of your duties when responding to these questions.**

Q35 Job A A job where you are often required to make important decisions

Job B A job with pleasant people to work with

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

Q36 Job A A job in which greater responsibility is given to those who do the best work

Job B A job in which greater responsibility is given to loyal employees who have the most seniority

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

Q37 Job A A job with very satisfying team work

Job B A job which allows you to use your skills and abilities to the fullest

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

Q38 Job A A job in which there is a real chance for you to develop new skills and advance in the organization

Job B A job which provides lots of vacation time and excellent benefits

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

Q39 Job A A job with a supervisor that treats you fairly and respects you

Job B A job which provides constant opportunities for you to learn new and interesting things

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

Q40 Job A A job with very good pay Job B

A job where there is a considerable opportunity to be creative and innovative

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

Q41 Job A A job which offers little or no challenge

Job B A job that requires you to be completely isolated from co-workers

1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)

End of Block: Section 6

Start of Block: Section 7

Q64 Which is the highest degree level have you been awarded in any field?

- ☐ Bachelors (1)
- ☐ Masters (2)
- ☐ PhD (3)
- ☐ Professional Doctorate, JD or MD (4)
- ☐ MBA (5)

Q49 What is your sex?

- ○ Male (1)
- ○ Female (2)
- ○ I prefer not to answer (3)

Q47 Choose one or more races that you consider yourself to be:

- ☐ White (1)
- ☐ Black or African American (2)
- ☐ American Indian or Alaska Native (3)
- ☐ Asian (4)
- ☐ Native Hawaiian or Pacific Islander (5)
- ☐ Other (6) _____
- ☐ I prefer not to answer (7)

Q51 Have you ever served in the US Armed Forces?

- ○ Yes (1)
- ○ No (2)
- ○ I prefer not to answer (3)

Q63 Please indicate the answer that includes your annual income in (previous year) before taxes.

- ○ Less than $30,000 (1)
- ○ $30,000 to $50,000 (2)
- ○ $50,000 to $100,000 (3)
- ○ $100,000 to $150,000 (4)
- ○ > $150,000 (5)
- ○ I prefer not to answer (6)

Q57 In which state do you currently reside?

▼ Alabama (1) ... I do not reside in the United States (53)

Appendix C: Tabular Hypothesis Models

Hypothesis 1 Model - Skill Variety

Survey Questions	Response	Series A	Series B	Series C
Independent Variable				
Q42 Do you currently manage or supervise other in your current role?		X		
Q67 What if any preparation related to management have you obtained?			X	X
Dependent Variable				
Q8 How much variety is there in your job?" To what extent does the job require you to do many different tasks that use your talents and skills?		X	X	X
Control Variable				
Q3 Select the field or fields in which you have earned a scientific degree or degrees:	Biology	X	X	X
	Microbiology	X	X	
	Chemistry			
	BioChemistry			
	Physics			X
	Engineering			
Q67 What if any preparation related to management have you obtained?	None			
	Mentorship Programs	X		X
	Informal Courses			
	Formal Education			
	Graduate Certificates			
	On the Job Training	X		X
Q59 How many years of managerial experience do you have?	<2			
	>2-5			X
	>5-10			
	>10-15			
	>15-20			
	>20	X	X	X
	None			
Q64 Which is the highest degree level have you been awarded in any field?	Bachelors		X	
	Masters			
	PhD	X		
	Professional Doctorate			
	MBA			
Q49 What is your sex?	Male		X	
	Female		X	
	I prefer not to answer		X	
Q47 Choose one or more races that you consider yourself to be:	White			
	Black/African American			
	Native American			
	Asian			
	Pacific Islander			
	Other			
	I prefer not to answer			
Q63 Please indicate the answer that includes your annual income in before taxes.	<$30k			
	>$30-50k		X	
	>$50-100k			X
	>$100-150k	X		
	>$150k	X		
	I prefer not to answer			
R-Squared		0.218	0.15	0.221

Hypothesis 2 Model - Task Identity

Survey Questions	Response	*Series A*	*Series B*	*Series C*
Independent Variable				
Q42: Do you currently manage or supervise other in your current role?		X		
Q67: What if any preparation related to management have you obtained?			X	X
Dependent Variable				
Q9 To what extent does your job involve doing a whole identifiable piece of your work? The job is a complete set of tasks from the beginning to the end of a project or is it a smaller part of a complete project, which is finished by other people?		X	X	X
Control Variable				
Q3 Select the field or fields in which you have earned a scientific degree or degrees:	Biology			
	Microbiology			
	Chemistry			
	BioChemistry			
	Physics			X
	Engineering			X
Q67 What if any preparation related to management have you obtained?	None			
	Mentorship Programs			X
	Informal Courses			
	Formal Education			
	Graduate Certificates	X		
	On the Job Training	X		
Q59 How many years of managerial experience do you have?	<2			
	>2-5			
	>5-10			
	>10-15			X
	>15-20			
	>20	X	X	X
	None			
Q64 Which is the highest degree level have you been awarded in any field?	Bachelors			
	Masters			
	PhD	X		
	Professional Doctorate			
	MBA			
Q49 What is your sex?	Male			
	Female			
	I prefer not to answer			
Q47 Choose one or more races that you consider yourself to be:	White			X
	Black/African American		X	
	Native American			
	Asian			
	Pacific Islander			
	Other			
	I prefer not to answer			
Q63 Please indicate the answer that includes your annual income in before taxes.	<$30k			
	>$30-50k	X		
	>$50-100k	X		
	>$100-150k	X		
	>$150k	X		
	I prefer not to answer			
R-Squared		0.121	0.046	0.238

Hypothesis 3 Model - Task Significance

Survey Questions	Response	*Series A*	*Series B*	*Series C*
Independent Variable				
Q42: Do you currently manage or supervise other in your current role?		X		
Q67: What if any preparation related to management have you obtained?			X	X
Dependent Variable				
Q10 In general, how significant or important is your job? Do the results of your work significantly affect the well-being of other peoples lives?		X	X	X
Q23 I feel a great amount of responsibility for the work I do.		X	X	X
Control Variable				
Q3 Select the field or fields in which you have earned a scientific degree or degrees:	Biology			X
	Microbiology	X	X	
	Chemistry			
	BioChemistry			
	Physics			
	Engineering			
Q67 What if any preparation related to management have you obtained?	None			
	Mentorship Programs			X
	Informal Courses			
	Formal Education	X		
	Graduate Certificates			
	On the Job Training	X		X
Q59 How many years of managerial experience do you have?	<2			
	>2-5			
	>5-10	X	X	
	>10-15			
	>15-20			
	>20			
	None			
Q64 Which is the highest degree level have you been awarded in any field?	Bachelors	X	X	
	Masters			
	PhD		X	
	Professional Doctorate			
	MBA			
Q49 What is your sex?	Male			
	Female			
	I prefer not to answer			
Q47 Choose one or more races that you consider yourself to be:	White	X		X
	Black/African American			
	Native American			
	Asian			
	Pacific Islander			
	Other			
	I prefer not to answer			
Q63 Please indicate the answer that includes your annual income in before taxes.	<$30k			
	>$30-50k			
	>$50-100k			
	>$100-150k	X	X	
	>$150k			
	I prefer not to answer			
R-Squared		0.207	0.198	0.215

Hypothesis 4 Model - Autonomy

Survey Questions	Response	*Series A*	*Series B*	*Series C*
Independent Variable				
Q42: Do you currently manage or supervise other in your current role?		X		
Q67: What if any preparation related to management have you obtained?			X	X
Dependent Variable				
Q6 To what extent does your job require you to work closely with other people?		X	X	X
Q7 How much autonomy is there in your job? To what extent does your job permit you to decide on your own how to go about doing your work?		X	X	X
Control Variable				
Q3 Select the field or fields in which you have earned a scientific degree or degrees:	Biology			
	Microbiology			
	Chemistry		X	
	BioChemistry			
	Physics			
	Engineering			
Q67 What if any preparation related to management have you obtained?	None			
	Mentorship Programs			X
	Informal Courses			
	Formal Education		X	
	Graduate Certificates			X
	On the Job Training	X		
Q59 How many years of managerial experience do you have?	<2			
	>2-5			
	>5-10	X	X	
	>10-15		X	
	>15-20			
	>20			
	None			
Q64 Which is the highest degree level have you been awarded in any field?	Bachelors	X		
	Masters			
	PhD			
	Professional Doctorate			
	MBA			
Q49 What is your sex?	Male			
	Female			
	I prefer not to answer			
Q47 Choose one or more races that you consider yourself to be:	White	X		
	Black/African American			
	Native American			
	Asian			
	Pacific Islander			
	Other			
	I prefer not to answer			
Q63 Please indicate the answer that includes your annual income in before taxes.	<$30k			
	>$30-50k		X	
	>$50-100k			X
	>$100-150k	X		
	>$150k	X	X	
	I prefer not to answer			
R-Squared		0.201	0.211	0.114

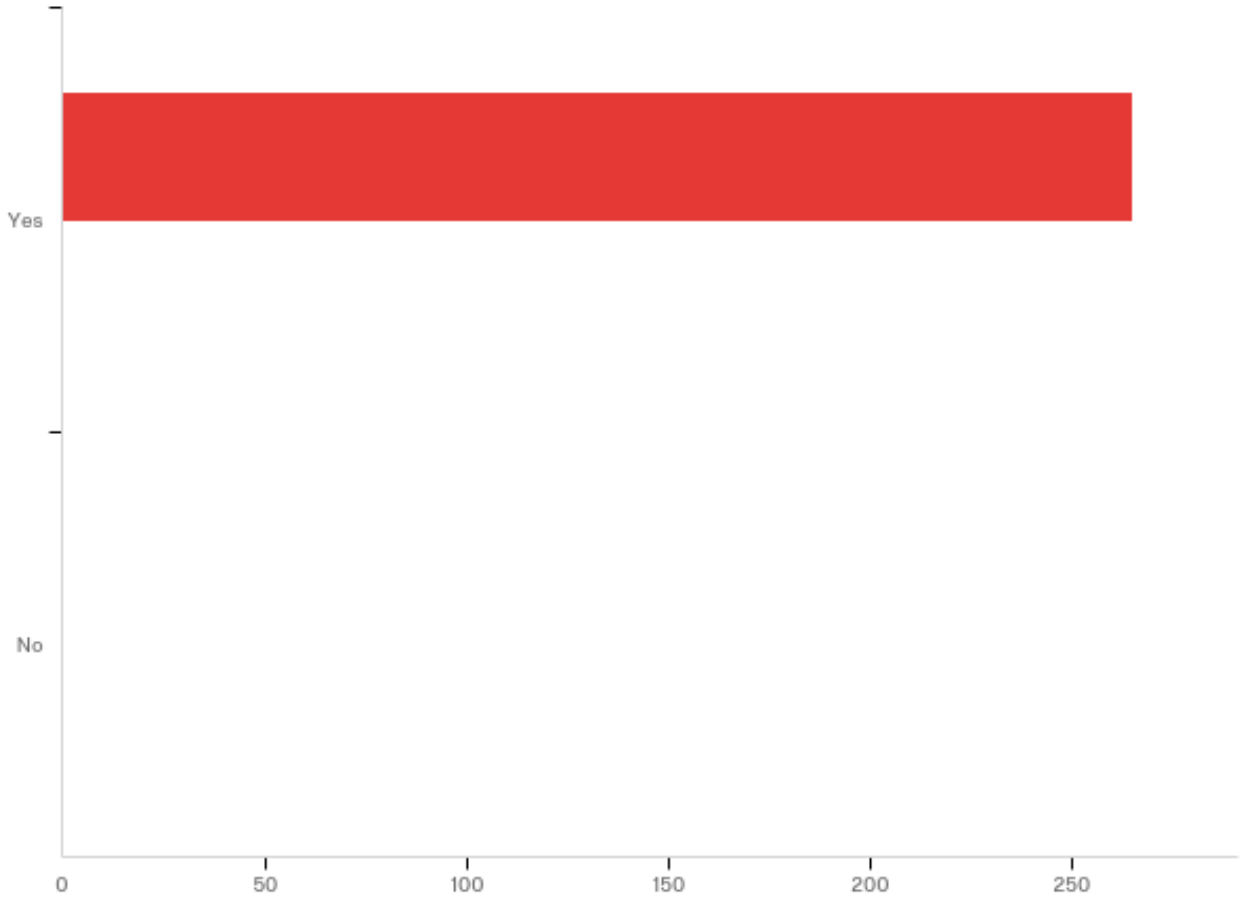
Hypothesis 5 Model - Feedback

Survey Questions	Response	*Series A*	*Series B*	*Series C*
Independent Variable				
Q42: Do you currently manage or supervise other in your current role?		X		
Q67: What if any preparation related to management have you obtained?			X	X
Dependent Variable				
Q11 How much autonomy is there in your job? To what extent does your job permit you to decide on your own how to go about doing your work?		X	X	X
Q12 In general, how much feedback is given by co-workers or supervisors to your performance of the job?		X	X	X
Control Variable				
Q3 Select the field or fields in which you have earned a scientific degree or degrees:	Biology	**X**	X	
	Microbiology	X	X	
	Chemistry		X	
	BioChemistry			
	Physics		X	X
	Engineering	X	X	X
Q67 What if any preparation related to management have you obtained?	None			
	Mentorship Programs			
	Informal Courses			
	Formal Education		X	
	Graduate Certificates			
	On the Job Training	X		X
Q59 How many years of managerial experience do you have?	<2			
	>2-5			
	>5-10	X		
	>10-15	X		X
	>15-20			X
	>20	X		
	None			
Q64 Which is the highest degree level have you been awarded in any field?	Bachelors			
	Masters			
	PhD			
	Professional Doctorate			
	MBA			
Q49 What is your sex?	Male			
	Female			
	I prefer not to answer			
Q47 Choose one or more races that you consider yourself to be:	White			
	Black/African American			
	Native American			
	Asian	X		
	Pacific Islander			
	Other			
	I prefer not to answer			
Q63 Please indicate the answer that includes your annual income in before taxes.	<$30k			
	>$30-50k		X	
	>$50-100k			
	>$100-150k			
	>$150k			
	I prefer not to answer			
R-Squared		0.196	0.121	0.188

Appendix D: Qualtrics Raw Results

Qualtrics Survey Results Unscrubbed Raw Data
Scientist2manger
April 10th 2018, 8:08 pm MDT

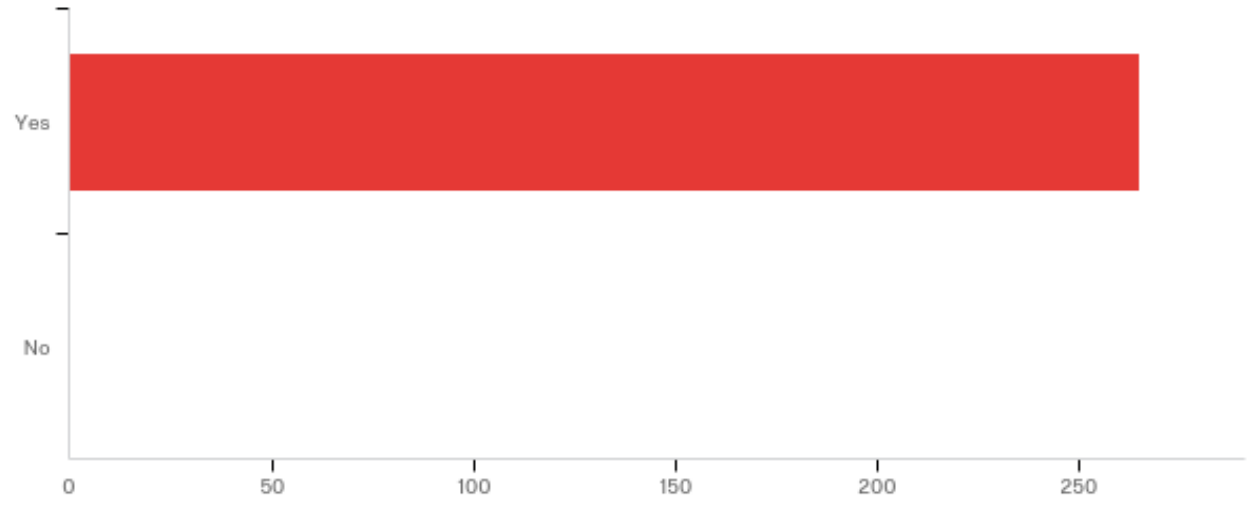
Q1 - Were you born between 1962 and 1992?



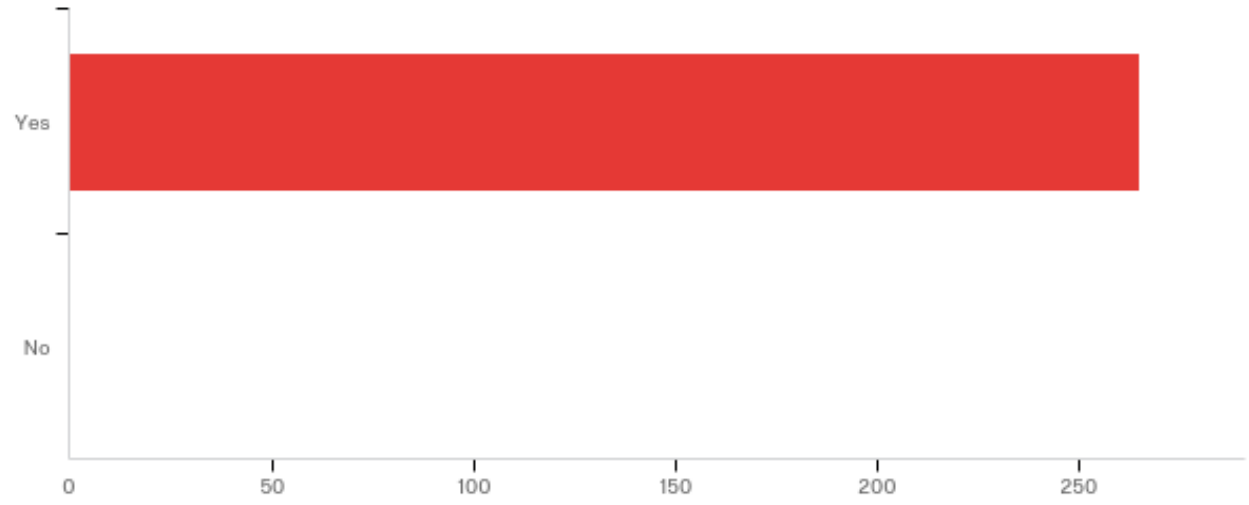
#	Were you born between 1962 and 1992?	Mean
1	Yes	1.00
2	No	0.00

#	Were you born between 1962 and 1992?	Mean
1	Yes	1.00
2	No	0.00

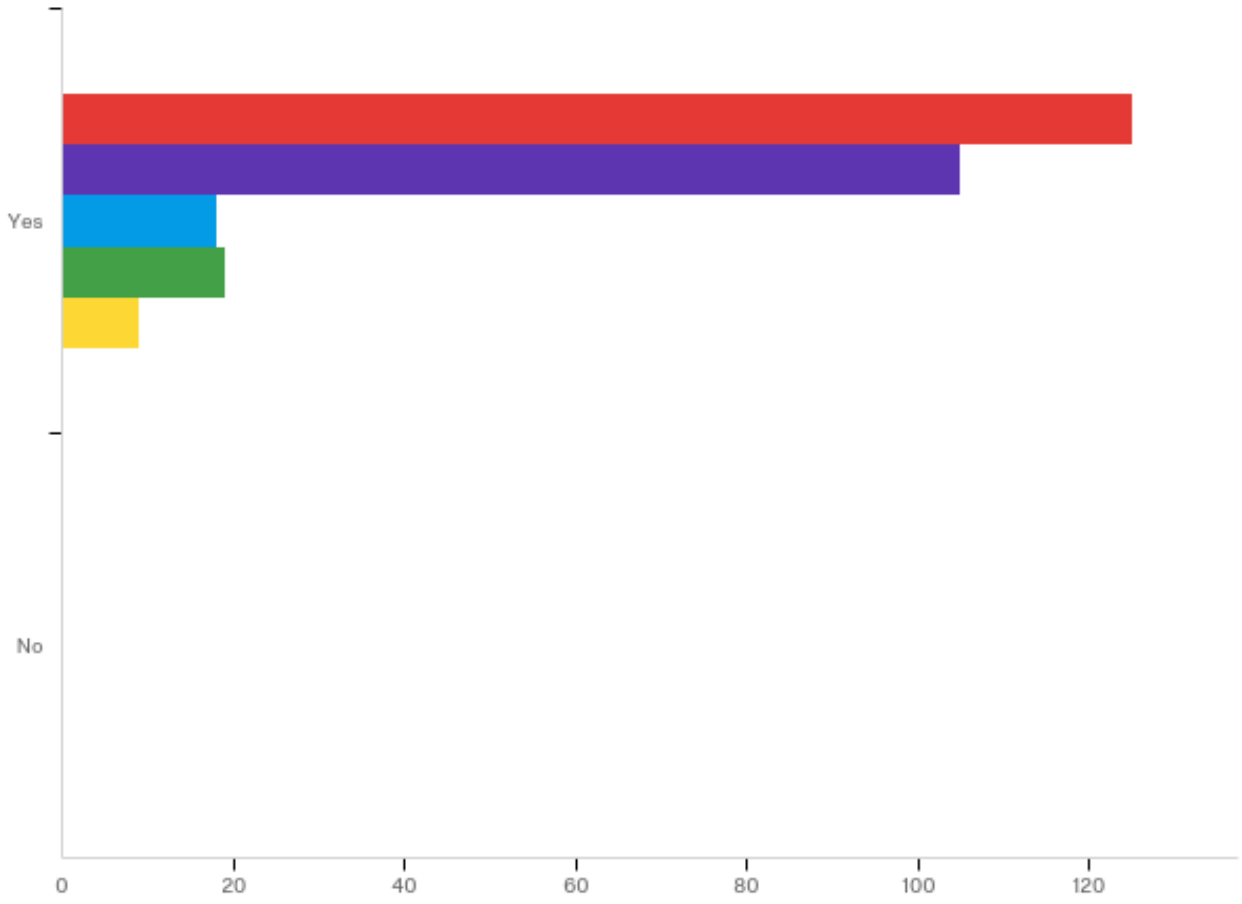
Q2 - Have you earned a Bachelor degree or higher?

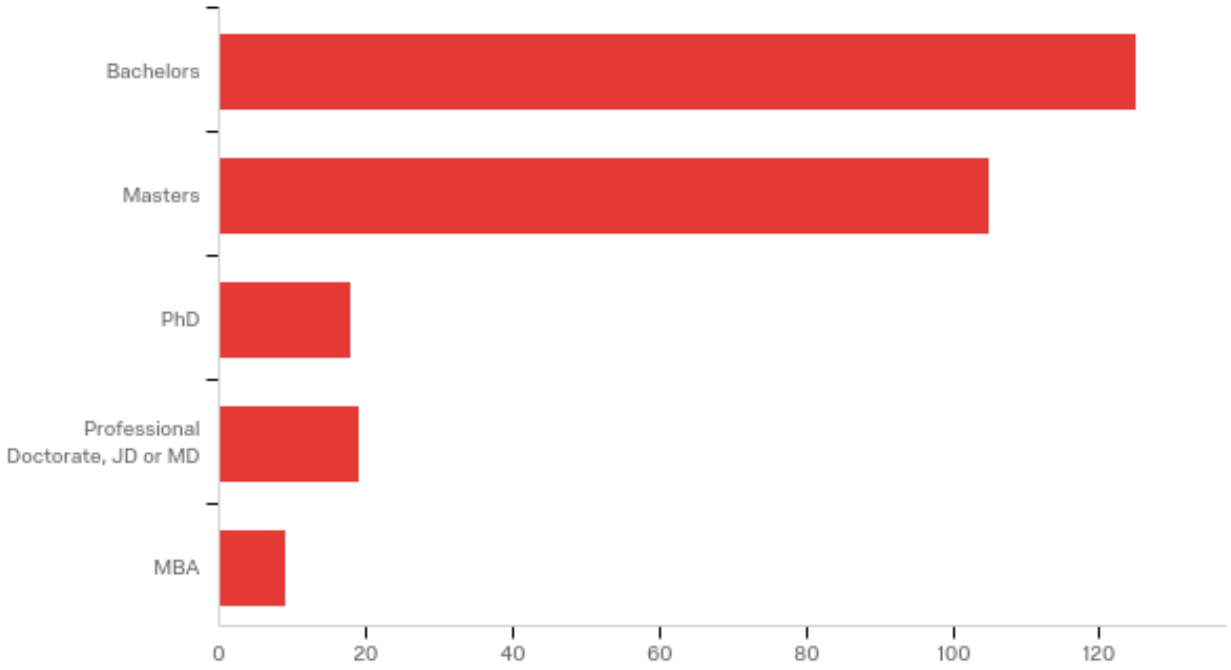


#	Answer	%	Count
1	Yes	100.00%	265
2	No	0.00%	0
	Total	100%	265



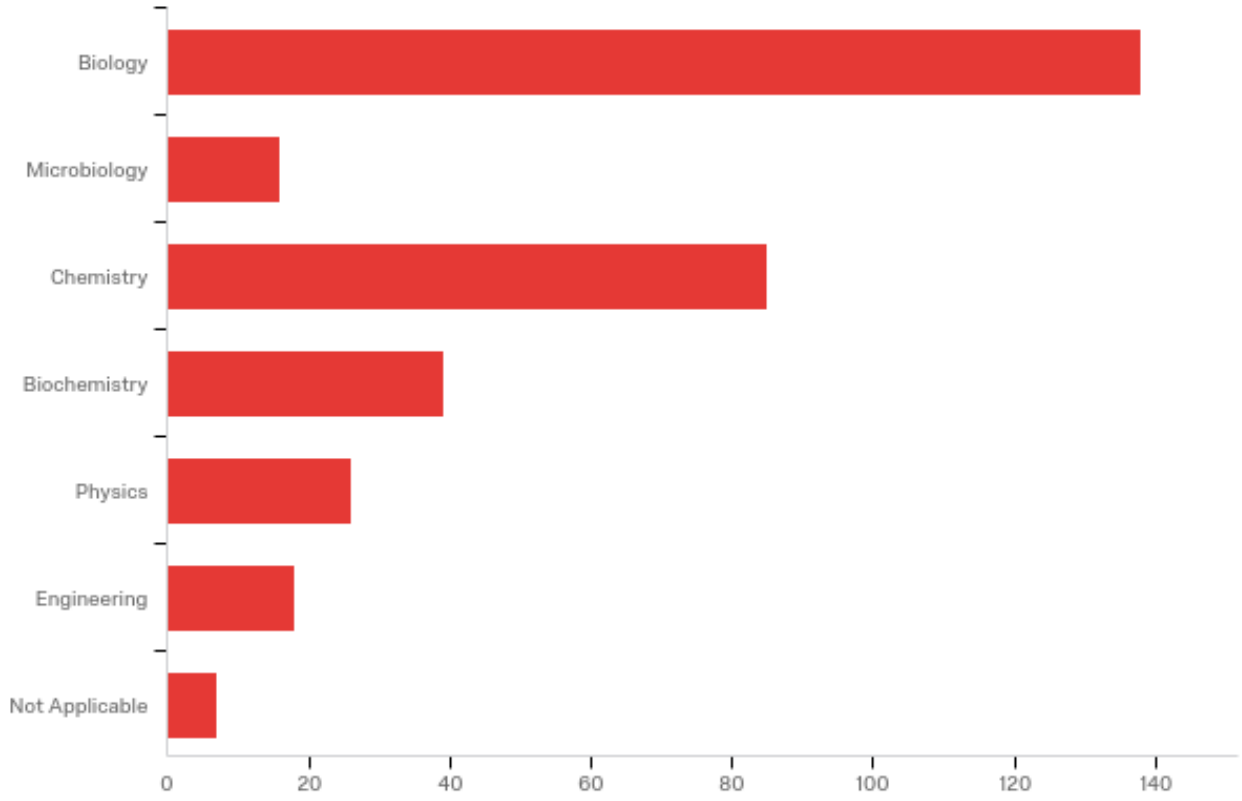
Q64 - Which is the highest degree level have you been awarded in any field?





#	Answer	%	Count
1	Bachelors	45.29%	125
2	Masters	38.04%	105
3	PhD	6.52%	18
4	Professional Doctorate, JD or MD	6.88%	19
5	MBA	3.26%	9
	Total	100%	276

Q3 - Select the field or fields in which you have earned a scientific degree or degrees:

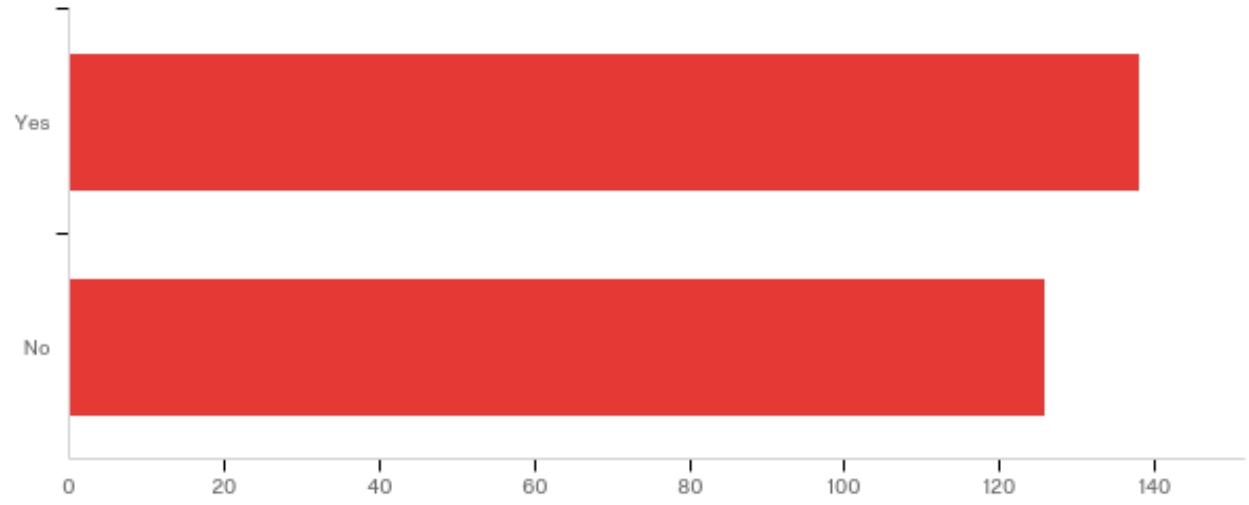


#	Answer	%	Count
1	Biology	41.95%	138
2	Microbiology	4.86%	16
3	Chemistry	25.84%	85
4	Biochemistry	11.85%	39
5	Physics	7.90%	26
6	Engineering	5.47%	18
7	Not Applicable	2.13%	7
	Total	100%	329

Data source misconfigured for this visualization

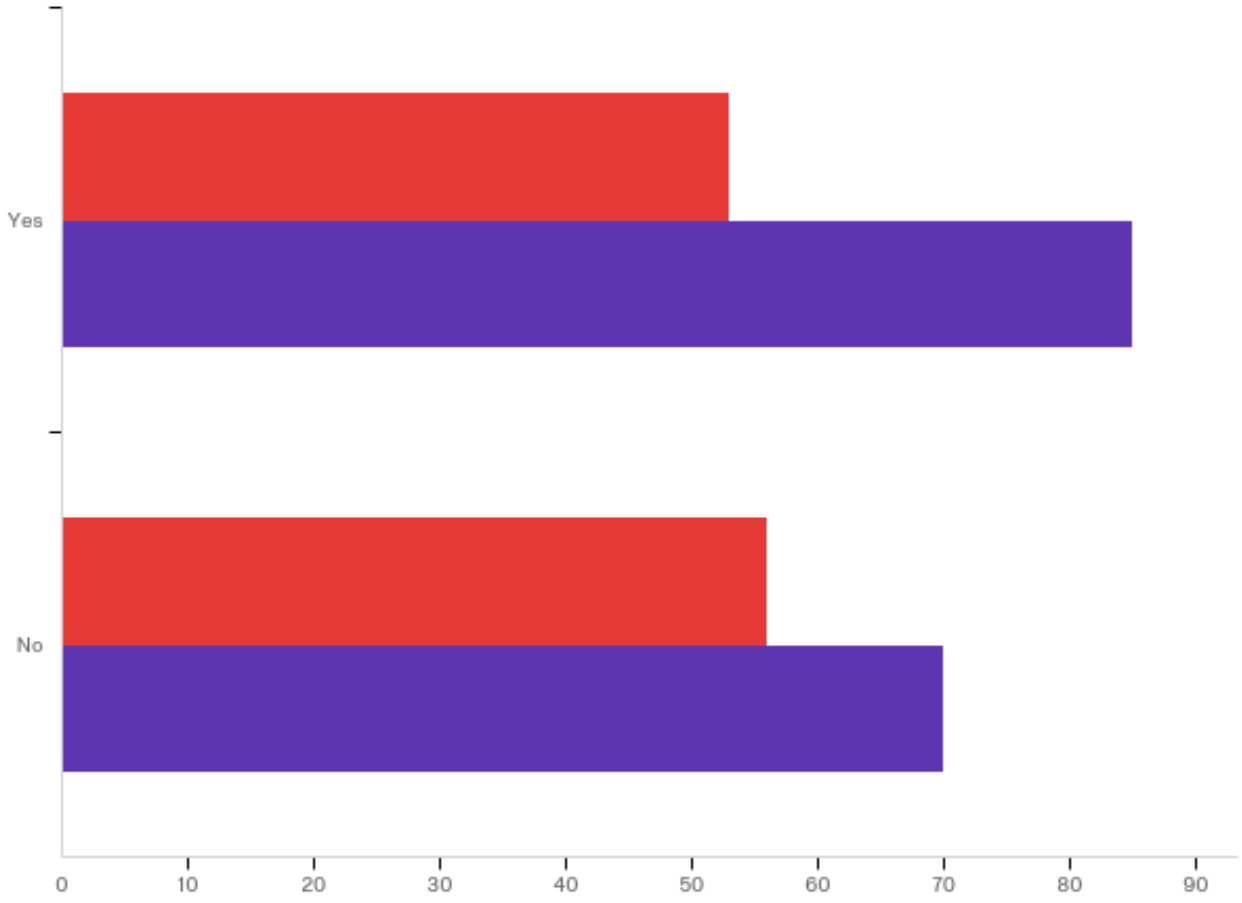
#	Answer	%	Count
1	Biology	41.95%	138
2	Microbiology	4.86%	16
3	Chemistry	25.84%	85
4	Biochemistry	11.85%	39
5	Physics	7.90%	26
6	Engineering	5.47%	18
7	Not Applicable	2.13%	7
	Total	100%	329

Q42 - Do you currently manage/supervise others in your role?



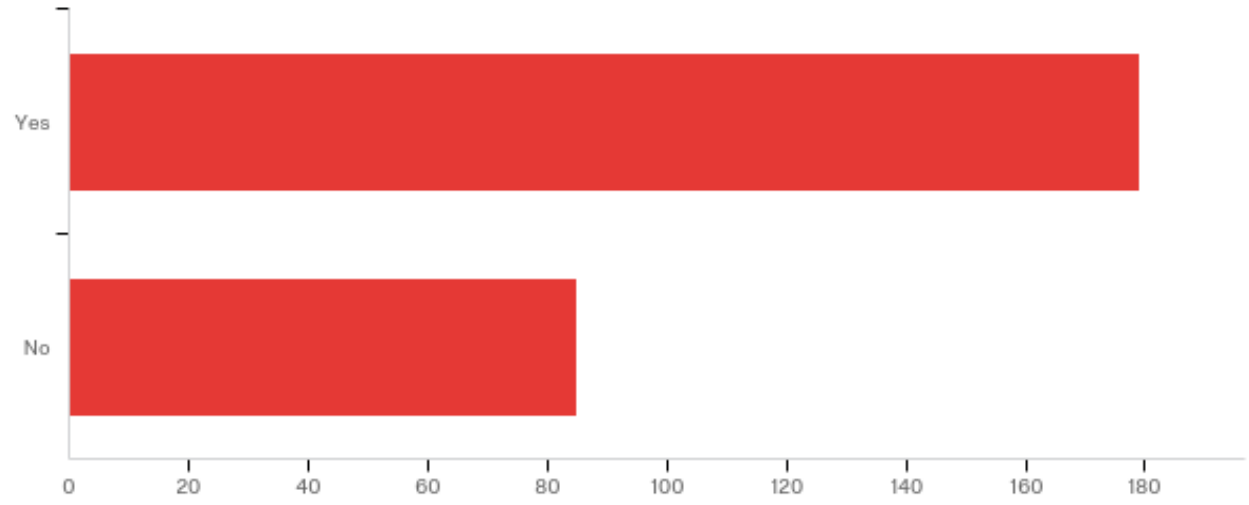
#	Answer	%	Count
1	Yes	52.27%	138
2	No	47.73%	126
	Total	100%	264

Q43 - If, No to previous question did you previously manage/supervise others and choose to return to a technical role?



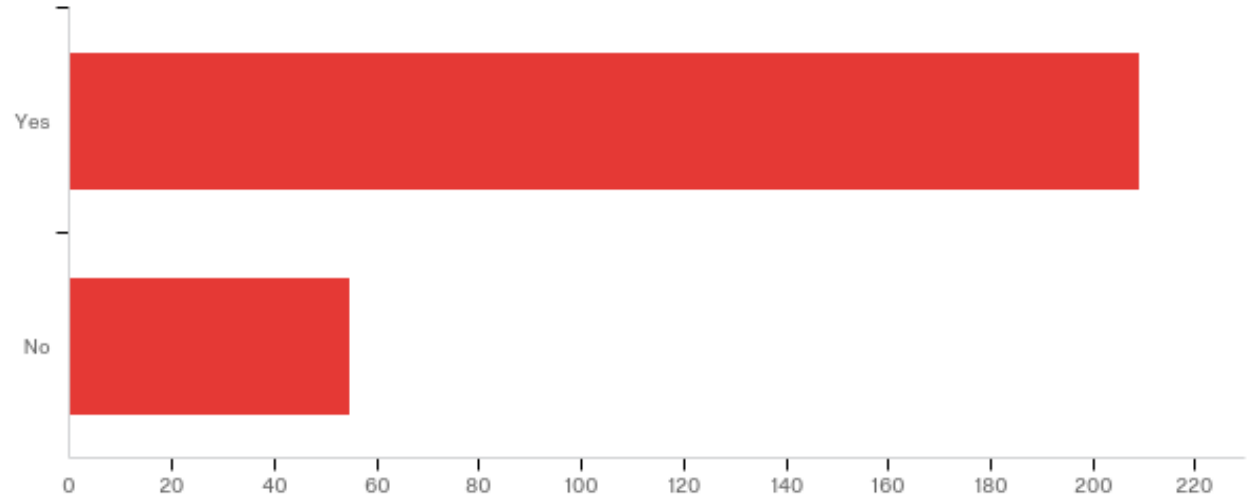
#	Answer	%	Count
2	No	58.71%	155
1	Yes	41.29%	109
	Total	100%	264

Q45 - Have you sought management/supervisory roles in your career?



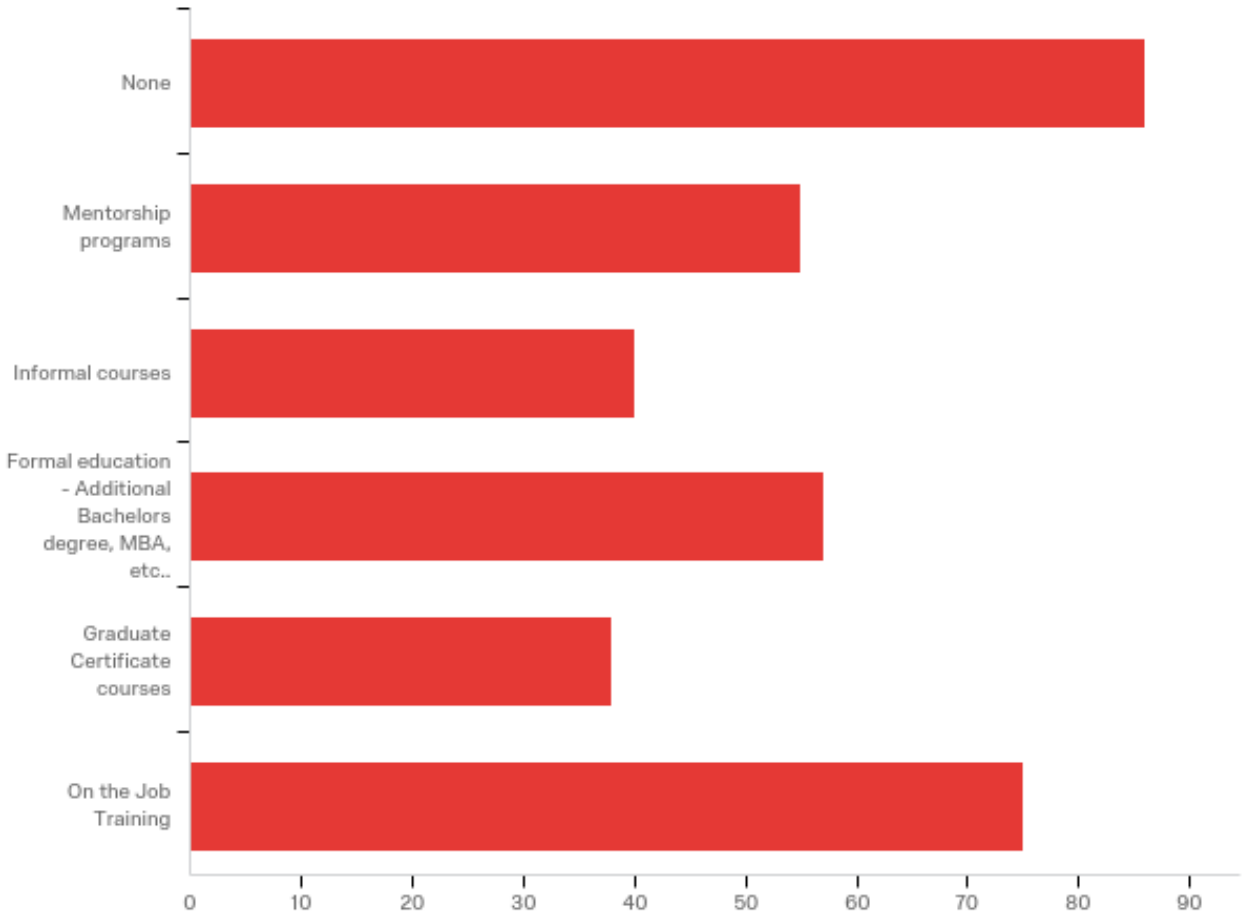
#	Answer	%	Count
1	Yes	67.80%	179
2	No	32.20%	85
	Total	100%	264

Q44 - Have you been afforded the opportunity to manage/supervise others in your career?



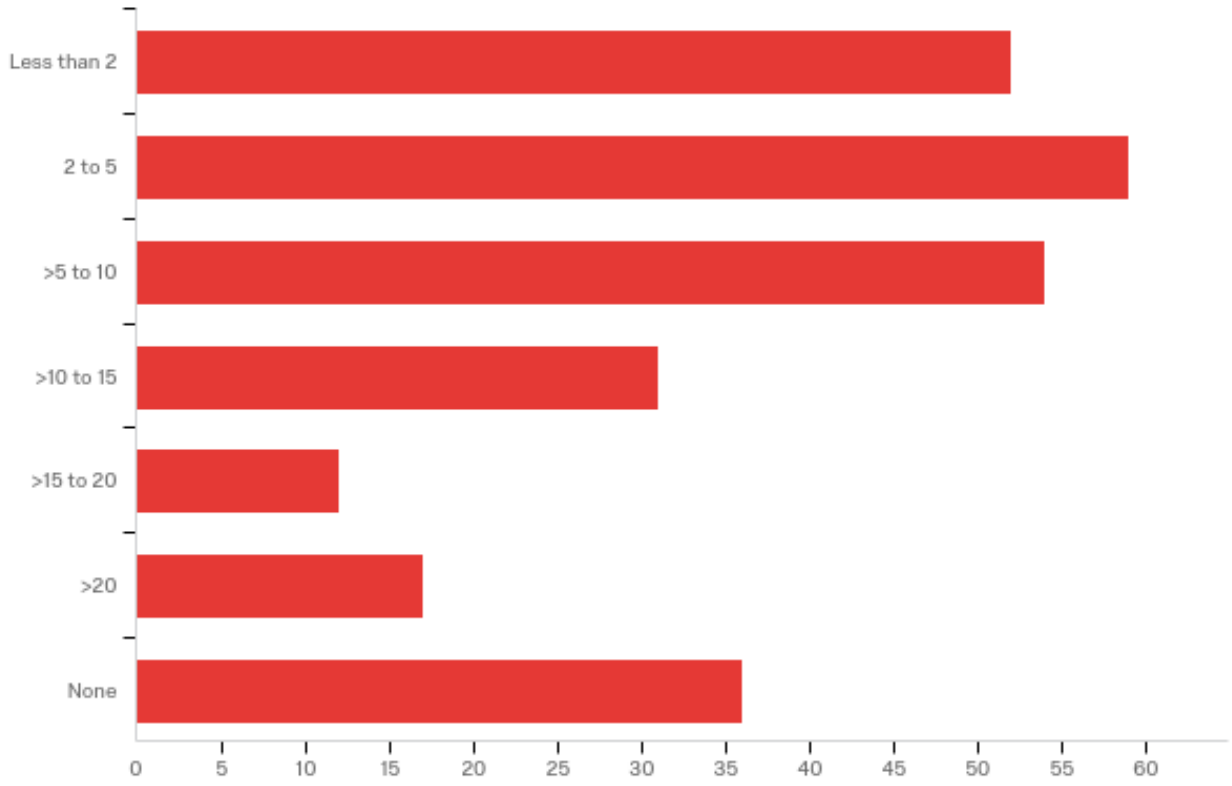
#	Answer	%	Count
1	Yes	79.17%	209
2	No	20.83%	55
	Total	100%	264

Q67 - What if any preparation related to management have you obtained?



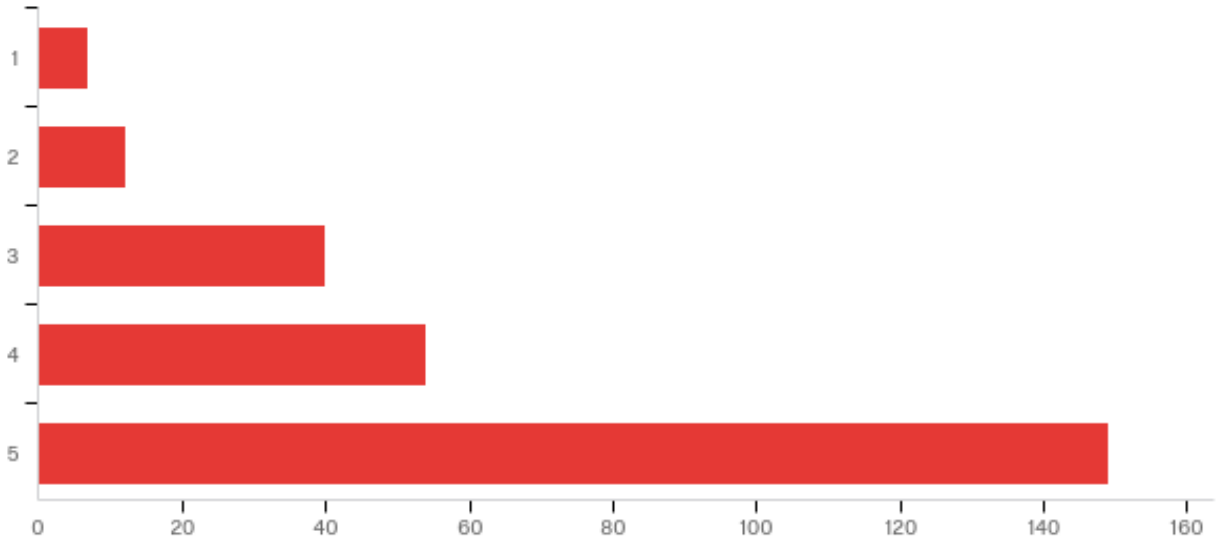
#	Answer	%	Count
1	None	24.50%	86
3	Mentorship programs	15.67%	55
4	Informal courses	11.40%	40
5	Formal education - Additional Bachelors degree, MBA, etc..	16.24%	57
6	Graduate Certificate courses	10.83%	38
7	On the Job Training	21.37%	75
	Total	100%	351

Q59 - How many years of managerial experience do you have?



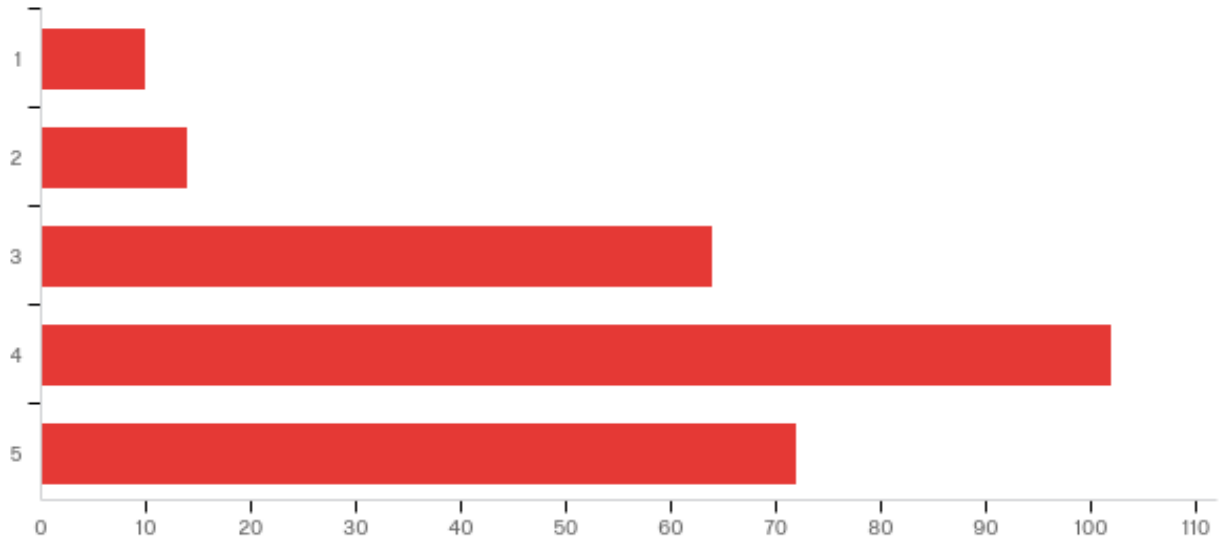
#	Answer	%	Count
1	Less than 2	19.92%	52
2	2 to 5	22.61%	59
3	>5 to 10	20.69%	54
4	>10 to 15	11.88%	31
5	>15 to 20	4.60%	12
6	>20	6.51%	17
7	None	13.79%	36
	Total	100%	261

Q6 - To what extent does your job require you to work closely with other people? (i.e. either client or others from within your organization) 1- Very little, dealing with others is not necessary to perform my job 3-Moderately dealing with others is necessary 5-Very much; dealing with others is absolutely essential to perform my job



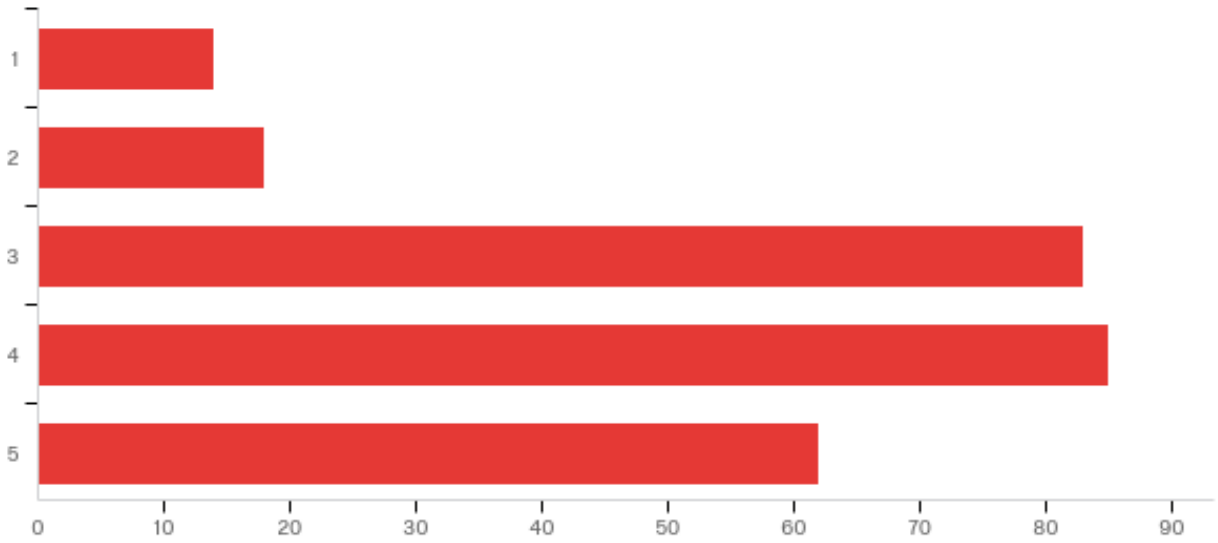
#	Answer	%	Count
1	1	2.67%	7
2	2	4.58%	12
3	3	15.27%	40
4	4	20.61%	54
5	5	56.87%	149
	Total	100%	262

Q7 - How much autonomy is there in your job? To what extent does your job permit you to decide on your own how to go about doing your work 1-Very little, the job gives me almost no person say in how to perform my work 3-Moderately; many things are standardized and not under my control, but I can make some decisions on how to perform my work 5-Very much; The job gives me complete control on how to perform my work



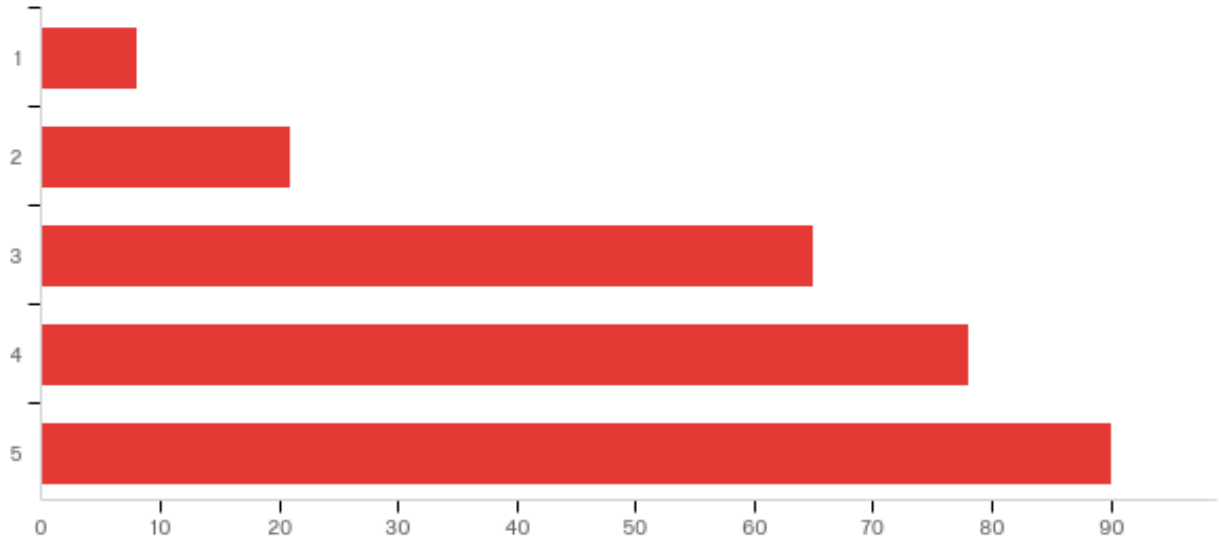
#	Answer	%	Count
1	1	3.82%	10
2	2	5.34%	14
3	3	24.43%	64
4	4	38.93%	102
5	5	27.48%	72
	Total	100%	262

Q8 - To what extent does your job involve doing a whole identifiable piece of your work? The job is a complete set of tasks from the beginning to the end of a project or is it a smaller part of a complete project, which is finished by other people? 1-The job is only a small part of the total project or product 3-The job is a moderate sized "chunk" of the total project or product 5-The job involves the total project or product as its deliverable



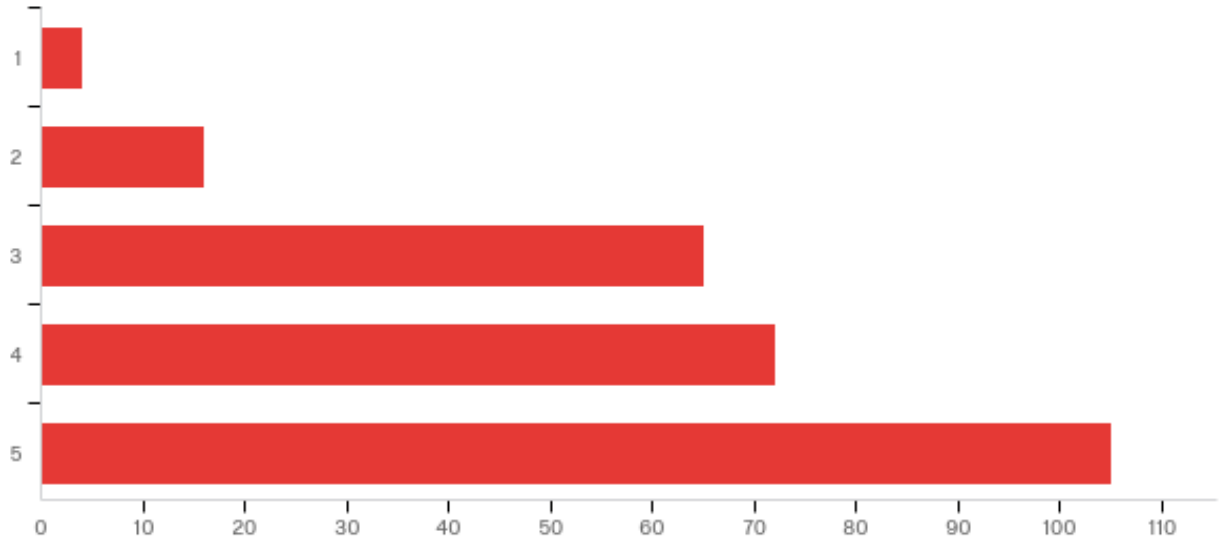
#	Answer	%	Count
4	4	32.44%	85
3	3	31.68%	83
5	5	23.66%	62
2	2	6.87%	18
1	1	5.34%	14
	Total	100%	262

Q9 - How much variety is there in your job? To what extent does the job require you to do many different tasks that use your talents and skills? 1- Very little; the job requires me to do the same tasks over and over 3- Moderately dealing; Moderate Variety 5-Very much; the job requires me to perform a number of different tasks that utilizes my skills and experience



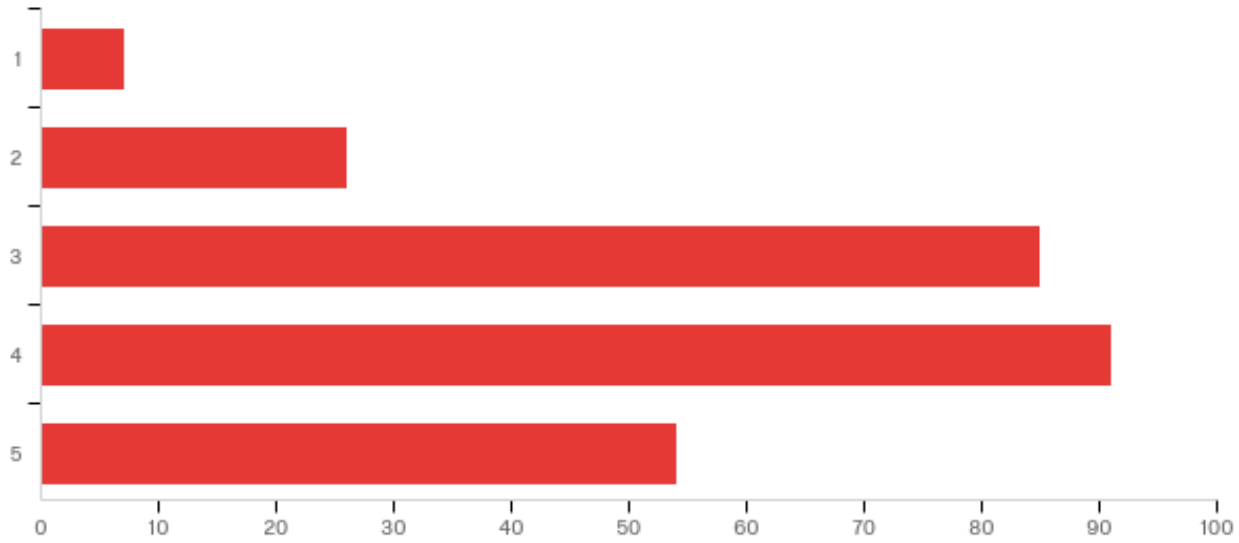
#	Answer	%	Count
1	1	3.05%	8
2	2	8.02%	21
3	3	24.81%	65
4	4	29.77%	78
5	5	34.35%	90
	Total	100%	262

Q10 - In general, how significant or important is your job? Do the results of your work significantly affect the well-being of other people lives? 1-Very little, the outcome of my work is unlikely to affect the lives of other people in a meaningful way 3-Moderately the outcome of my work is likely to affect the lives of other people in a meaningful way 5–Very much; the outcome of my work will absolutely to affect the lives of other people in a meaningful way



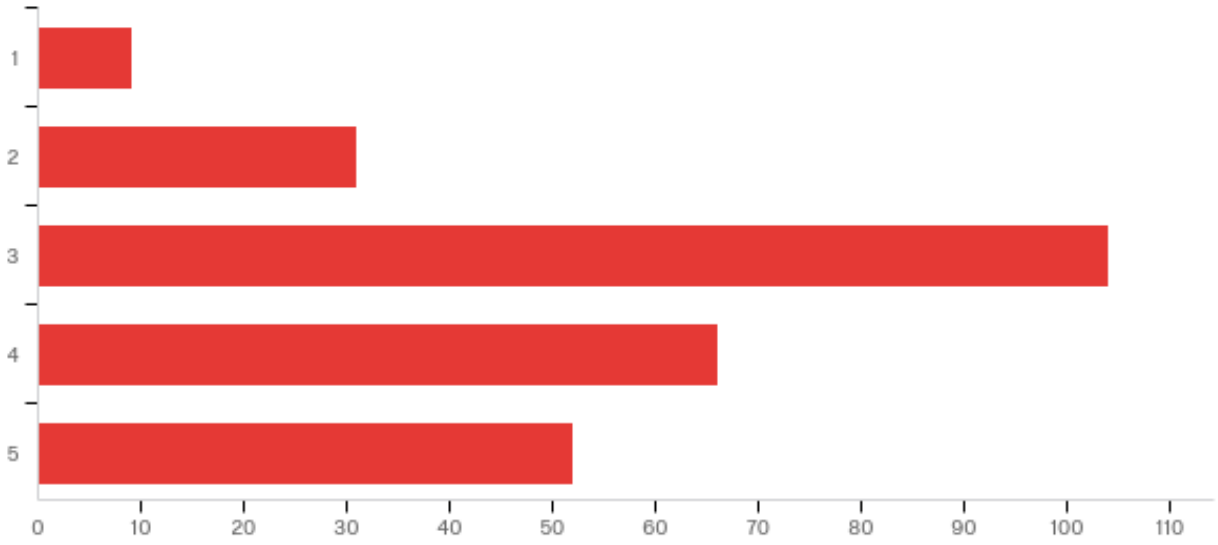
#	Answer	%	Count
1	1	1.53%	4
2	2	6.11%	16
3	3	24.81%	65
4	4	27.48%	72
5	5	40.08%	105
	Total	100%	262

Q11 - To what extent does the job itself provide you with information about your work performance? The job gives you clues along the way to let you know if the tasks are performed correctly, aside from co-worker feedback. 1-Very little, the tasks completion would not give me feedback 3-Moderately, some tasks in the routine give me feedback 5-Very much; the tasks are self-advising



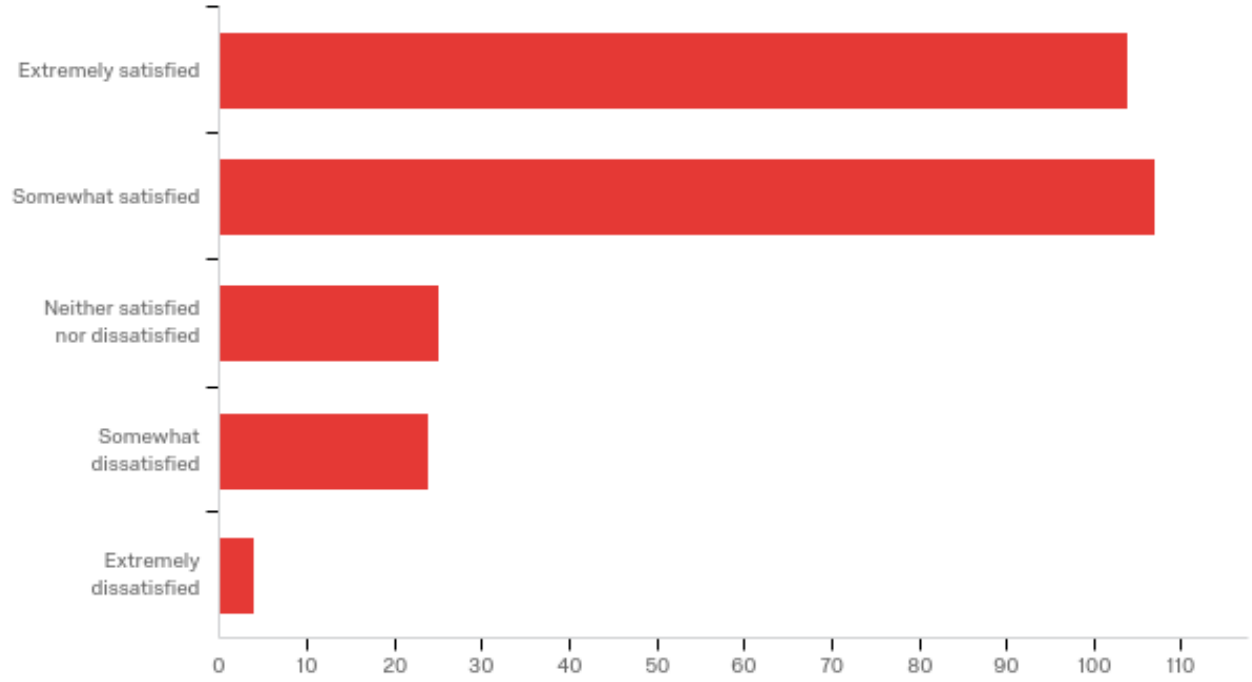
#	Answer	%	Count
1	1	2.66%	7
2	2	9.89%	26
3	3	32.32%	85
4	4	34.60%	91
5	5	20.53%	54
	Total	100%	263

Q12 - In general, how much feedback is given by co-workers or supervisors to your performance of the job 1- Very little, I receive little or no feedback on my task completion 3-Moderately I receive some useful feedback from co-workers or supervisors on my job performance 5-Very much; I receive regular feedback on my performance



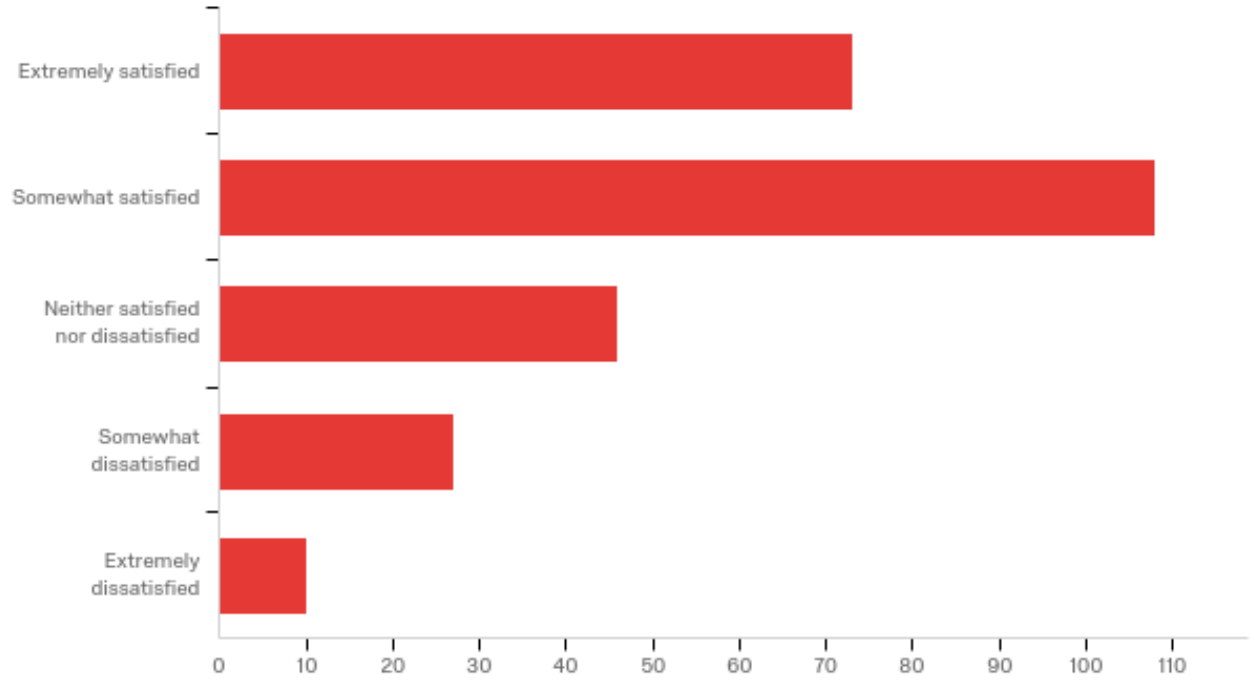
#	Answer	%	Count
3	3	39.69%	104
4	4	25.19%	66
5	5	19.85%	52
2	2	11.83%	31
1	1	3.44%	9
	Total	100%	262

Q13 - My overall satisfaction with my current role.



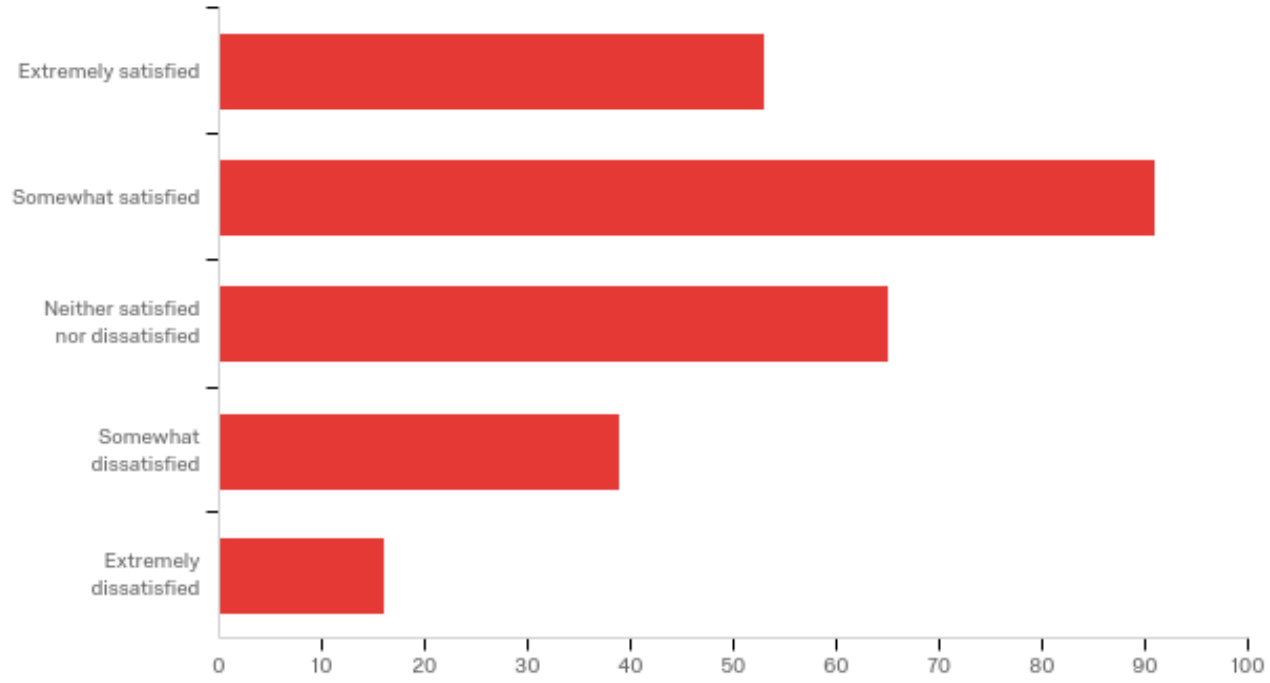
#	Answer	%	Count
1	Extremely satisfied	39.39%	104
2	Somewhat satisfied	40.53%	107
3	Neither satisfied nor dissatisfied	9.47%	25
4	Somewhat dissatisfied	9.09%	24
5	Extremely dissatisfied	1.52%	4
	Total	100%	264

Q14 - My overall satisfaction with my training/education opportunities in my current organization



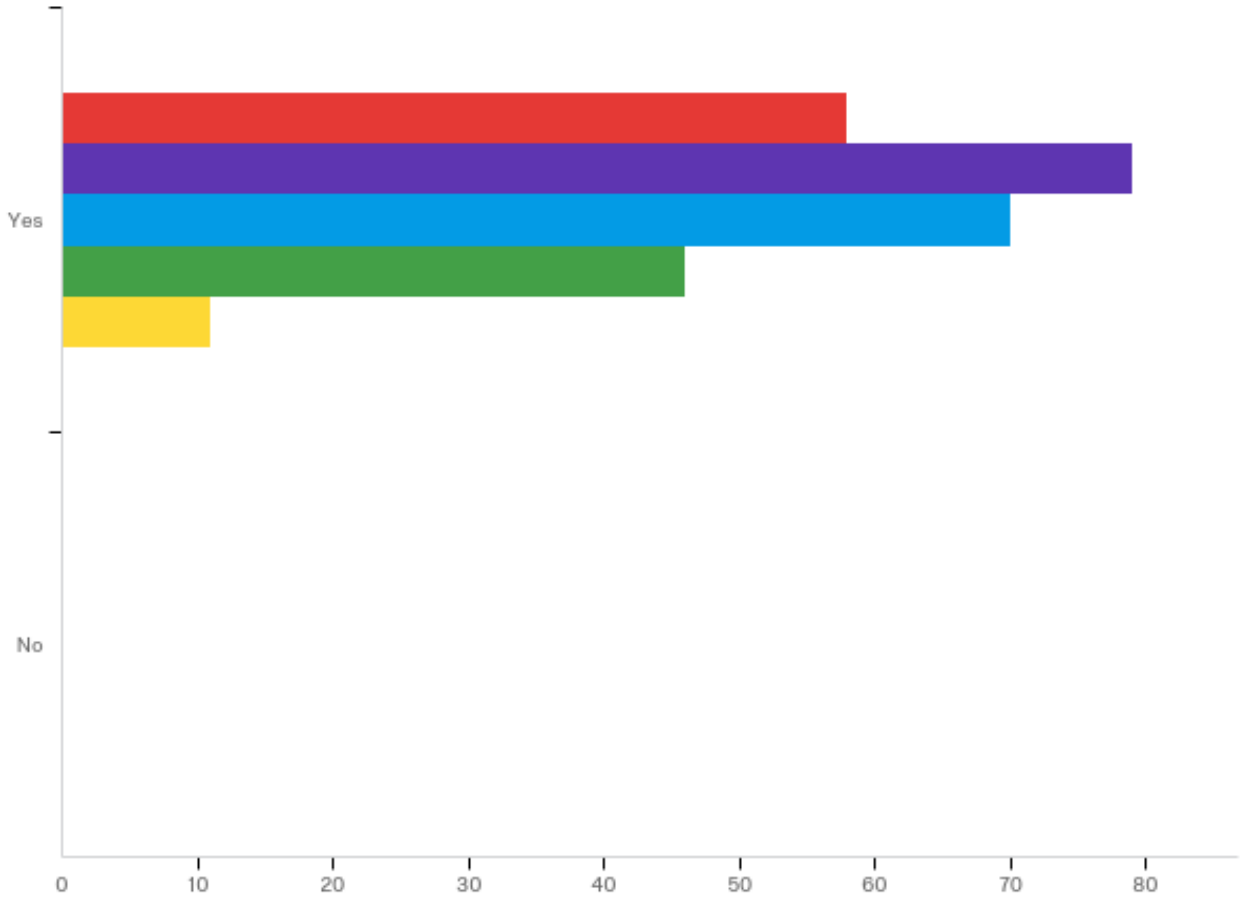
#	Answer	%	Count
1	Extremely satisfied	27.65%	73
2	Somewhat satisfied	40.91%	108
3	Neither satisfied nor dissatisfied	17.42%	46
4	Somewhat dissatisfied	10.23%	27
5	Extremely dissatisfied	3.79%	10
	Total	100%	264

Q15 - The training my organization provides to advance to the next level of responsibility



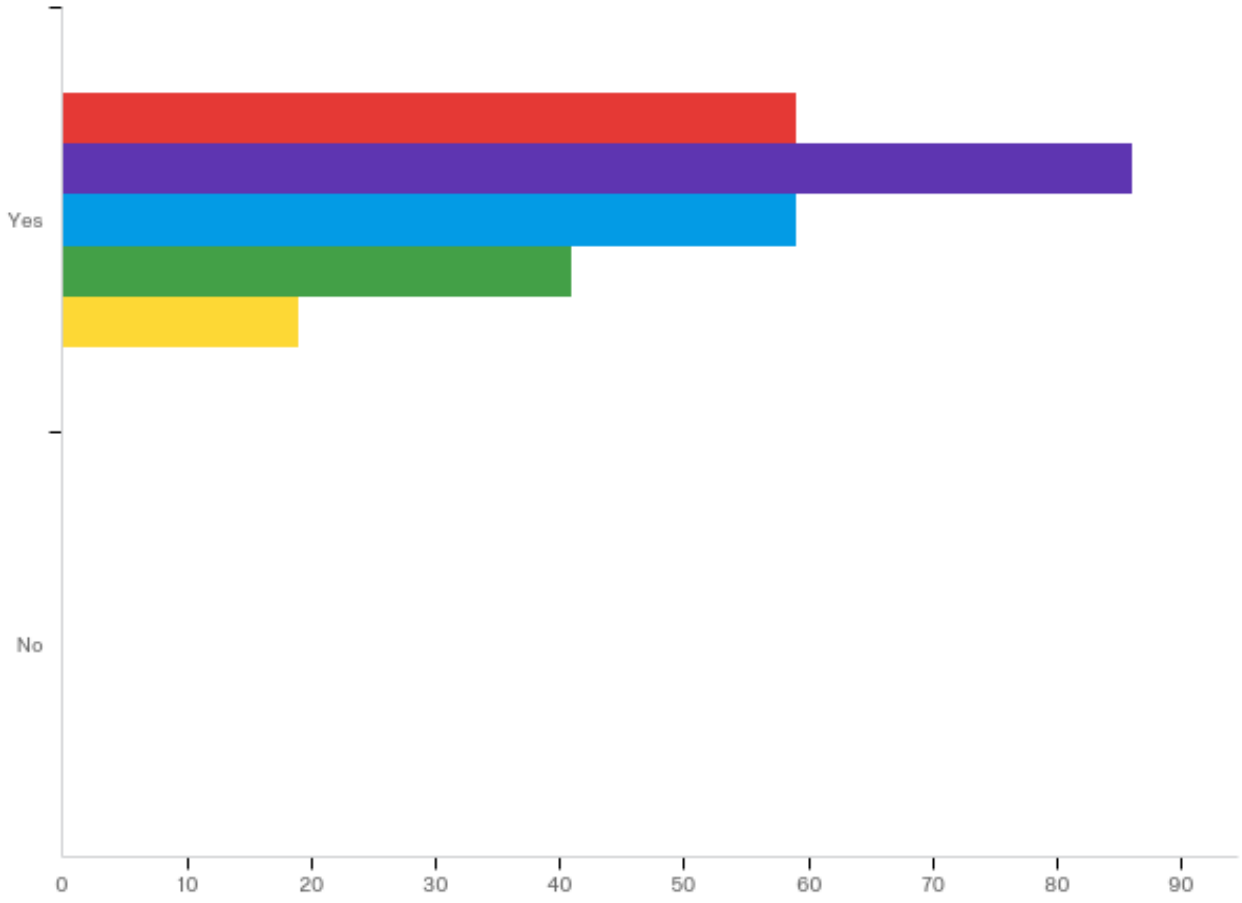
#	Answer	%	Count
1	Extremely satisfied	20.08%	53
2	Somewhat satisfied	34.47%	91
3	Neither satisfied nor dissatisfied	24.62%	65
4	Somewhat dissatisfied	14.77%	39
5	Extremely dissatisfied	6.06%	16
	Total	100%	264

Q16 - The organizational structure for the ability to choose between technical advancement and managerial roles



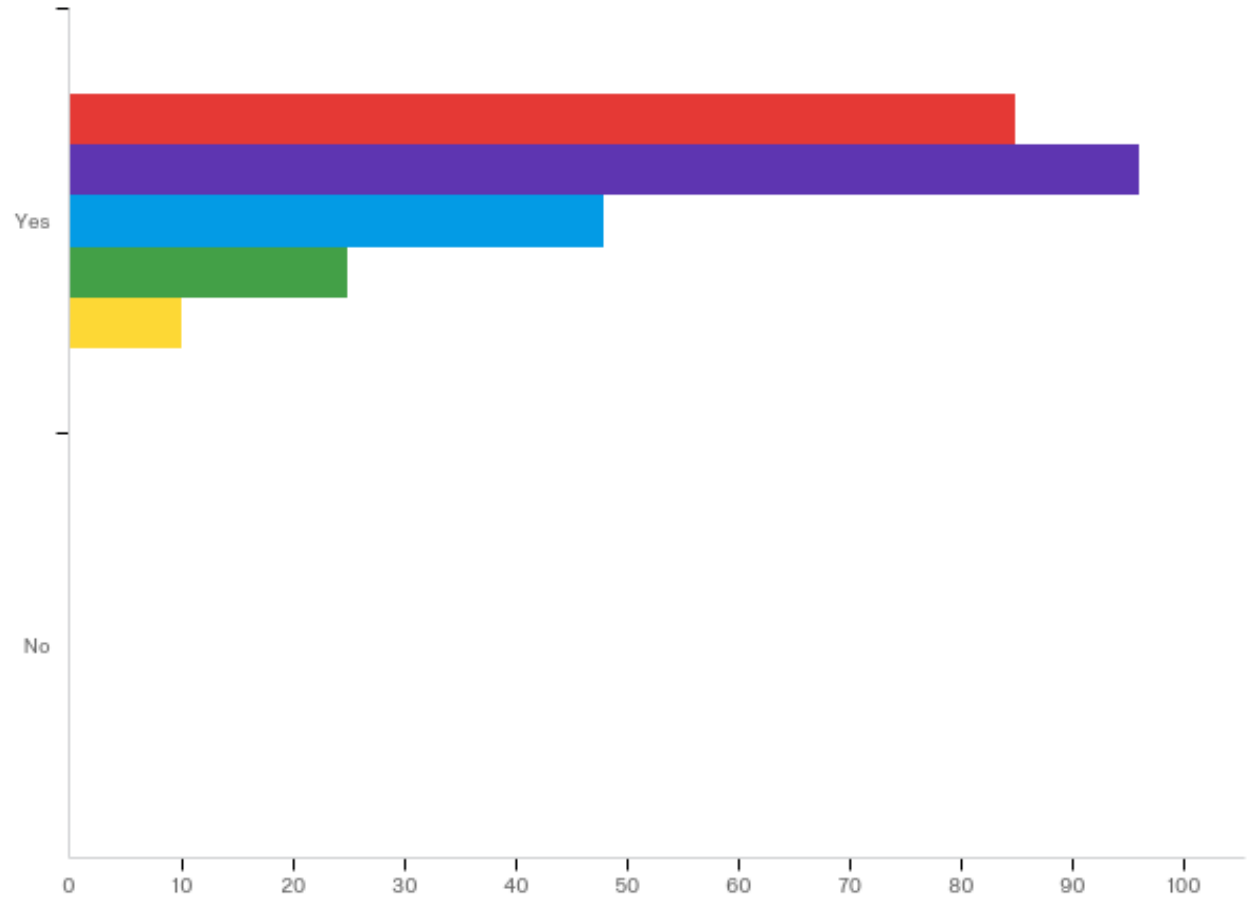
#	Question	Yes		No		Total
1	Extremely satisfied	100.00%	58	0.00%	0	58
2	Somewhat satisfied	100.00%	79	0.00%	0	79
3	Neither satisfied nor dissatisfied	100.00%	70	0.00%	0	70
4	Somewhat dissatisfied	100.00%	46	0.00%	0	46
5	Extremely dissatisfied	100.00%	11	0.00%	0	11

Q17 - The level of organizationally supported preparation, before becoming a manager



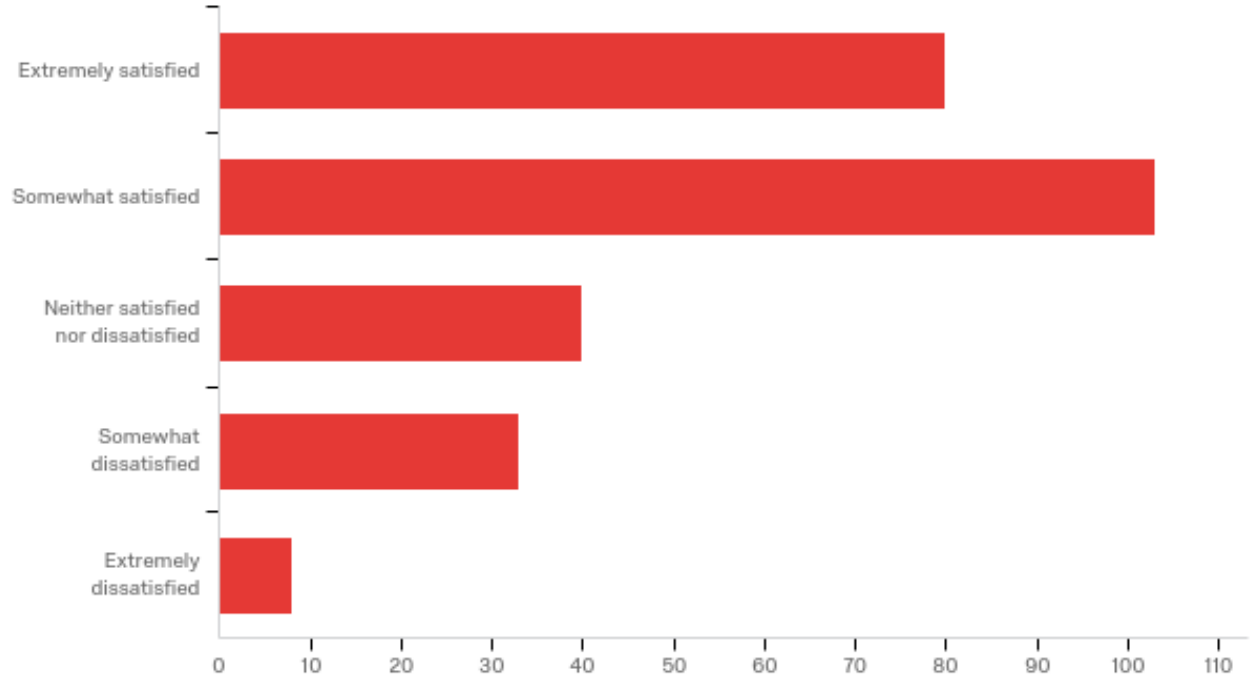
#	Question	Yes		No		Total
1	Extremely satisfied	100.00%	59	0.00%	0	59
2	Somewhat satisfied	100.00%	86	0.00%	0	86
3	Neither satisfied nor dissatisfied	100.00%	59	0.00%	0	59
4	Somewhat dissatisfied	100.00%	41	0.00%	0	41
5	Extremely dissatisfied	100.00%	19	0.00%	0	19

Q18 - My overall satisfaction with my career advancement



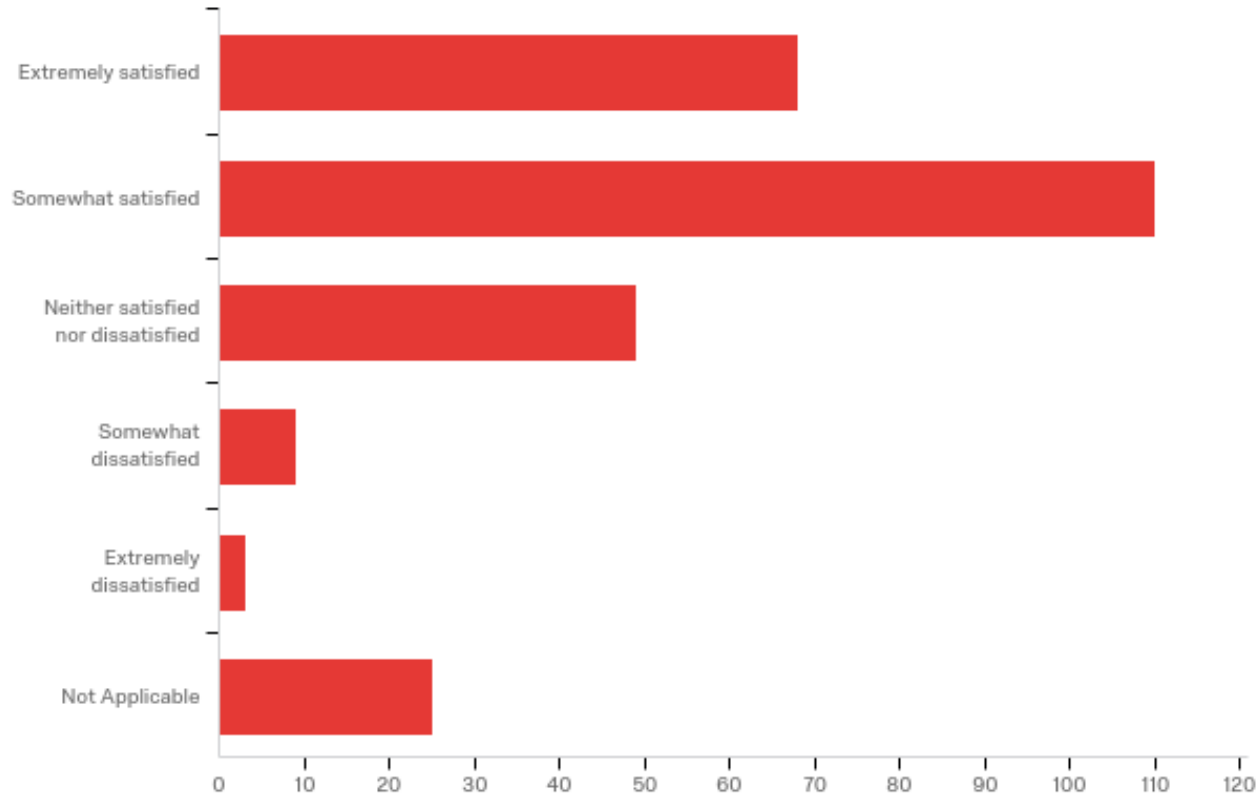
#	Question	Yes		No		Total
1	Extremely satisfied	100.00%	85	0.00%	0	85
2	Somewhat satisfied	100.00%	96	0.00%	0	96
3	Neither satisfied nor dissatisfied	100.00%	48	0.00%	0	48
4	Somewhat dissatisfied	100.00%	25	0.00%	0	25
5	Extremely dissatisfied	100.00%	10	0.00%	0	10

Q19 - My overall satisfaction with my organization



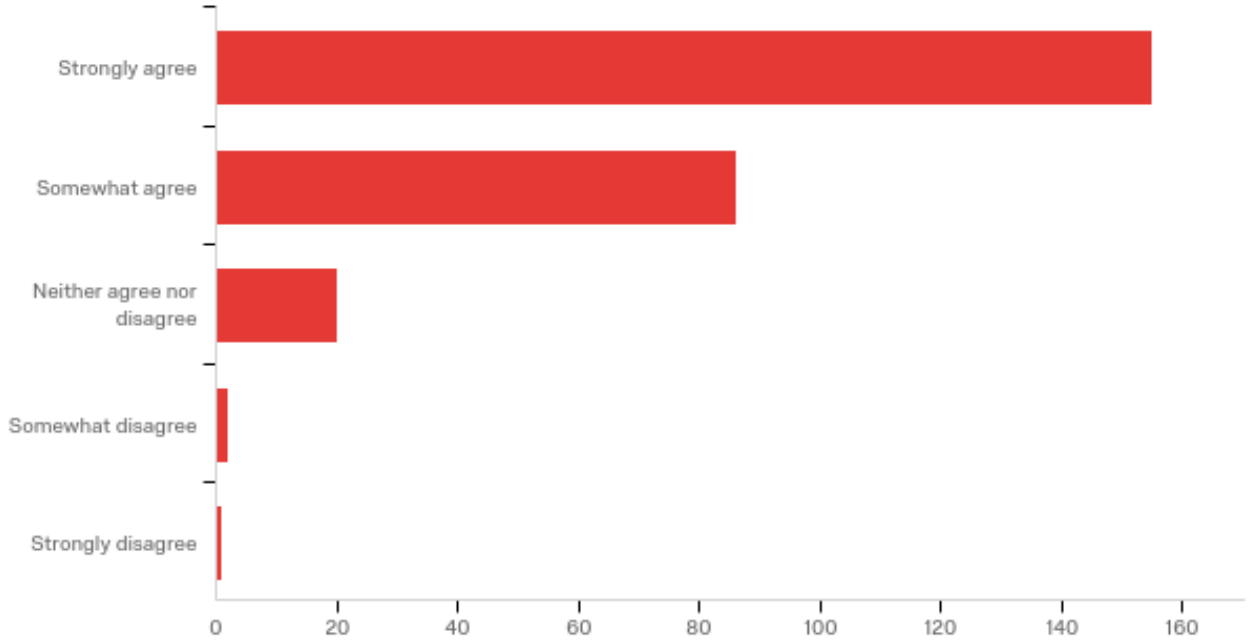
#	Answer	%	Count
1	Extremely satisfied	30.30%	80
2	Somewhat satisfied	39.02%	103
3	Neither satisfied nor dissatisfied	15.15%	40
4	Somewhat dissatisfied	12.50%	33
5	Extremely dissatisfied	3.03%	8
	Total	100%	264

Q20 - My level of satisfaction with managing others



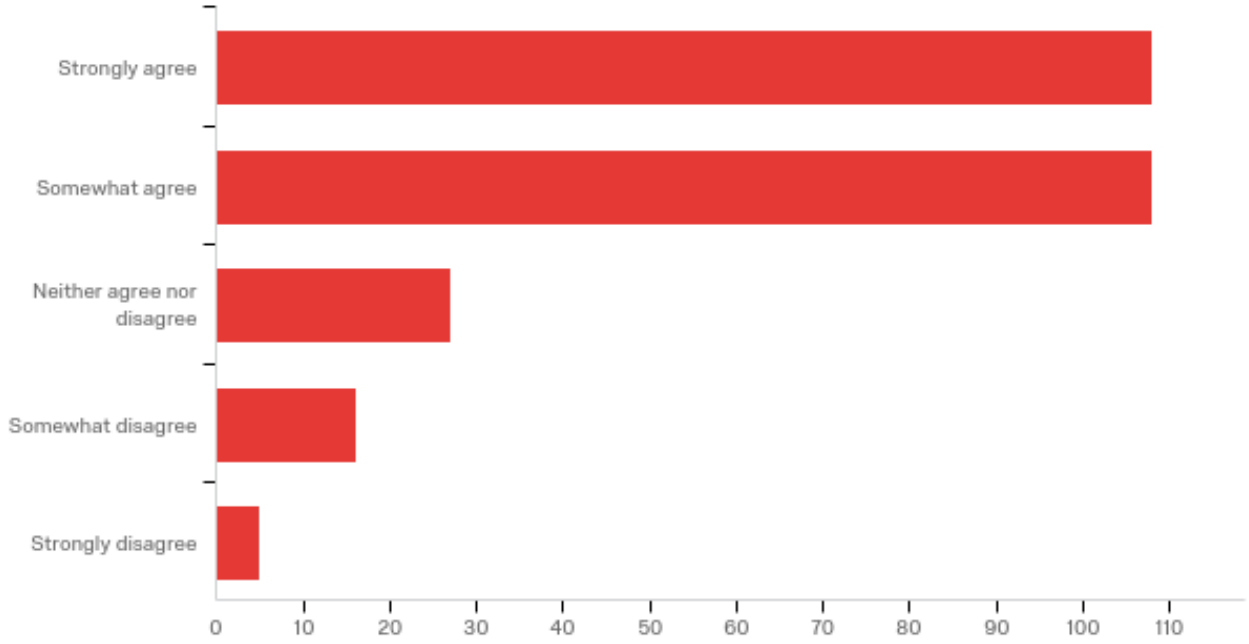
#	Answer	%	Count
2	Somewhat satisfied	41.67%	110
1	Extremely satisfied	25.76%	68
3	Neither satisfied nor dissatisfied	18.56%	49
6	Not Applicable	9.47%	25
4	Somewhat dissatisfied	3.41%	9
5	Extremely dissatisfied	1.14%	3
	Total	100%	264

Q21 - My opinion of myself goes up when I do this job well



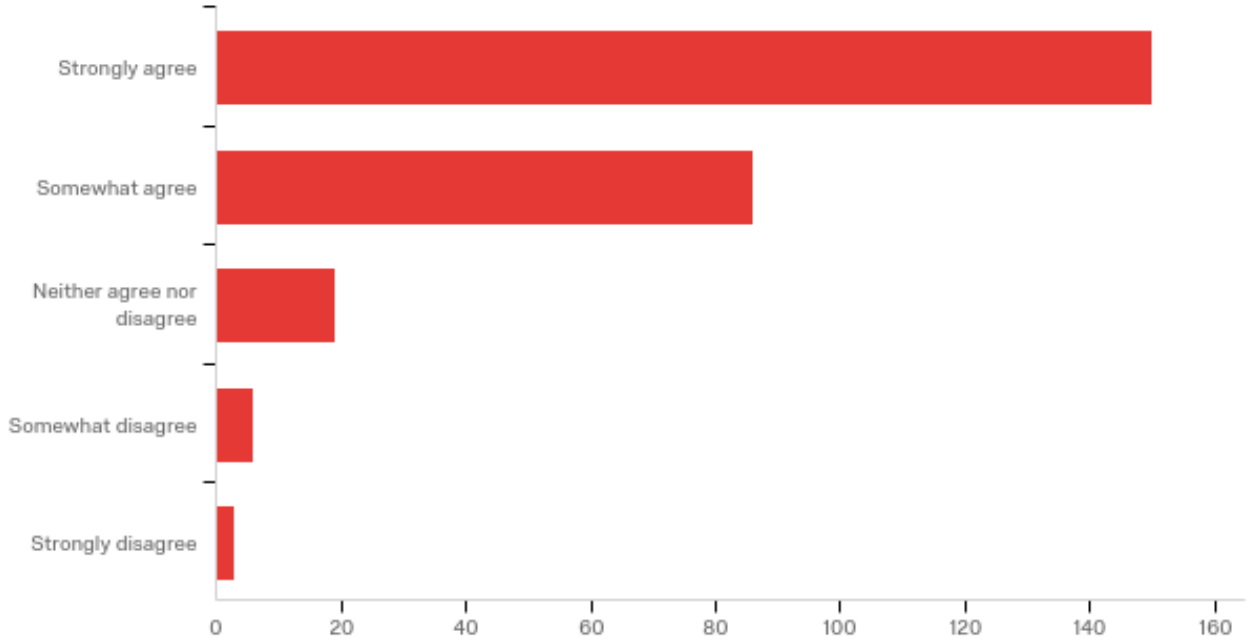
#	Answer	%	Count
1	Strongly agree	58.71%	155
2	Somewhat agree	32.58%	86
3	Neither agree nor disagree	7.58%	20
4	Somewhat disagree	0.76%	2
5	Strongly disagree	0.38%	1
	Total	100%	264

Q22 - Generally speaking I’m satisfied with this job



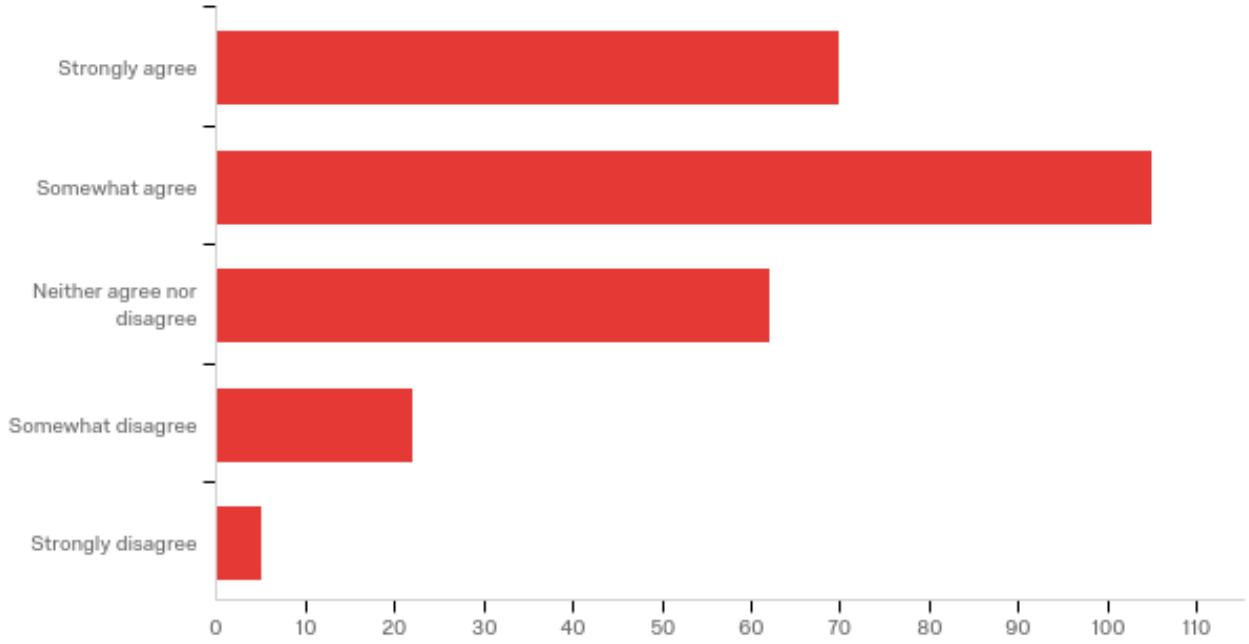
#	Answer	%	Count
1	Strongly agree	40.91%	108
2	Somewhat agree	40.91%	108
3	Neither agree nor disagree	10.23%	27
4	Somewhat disagree	6.06%	16
5	Strongly disagree	1.89%	5
	Total	100%	264

Q23 - I feel a great amount of responsibility for the work I do



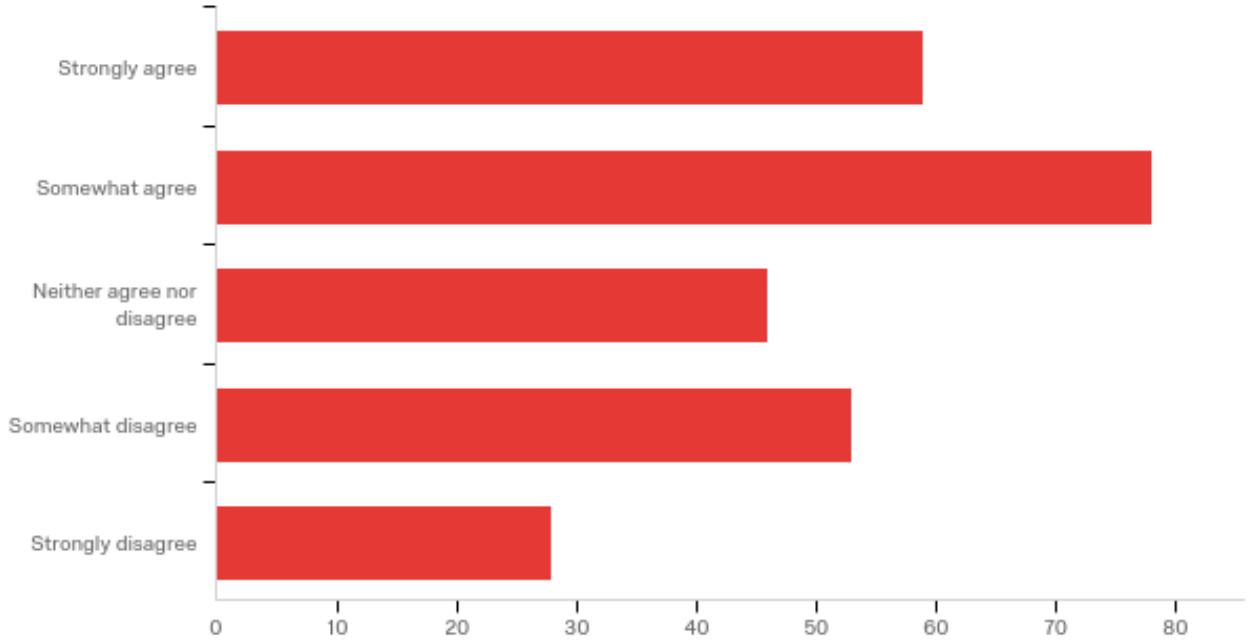
#	Answer	%	Count
1	Strongly agree	56.82%	150
2	Somewhat agree	32.58%	86
3	Neither agree nor disagree	7.20%	19
4	Somewhat disagree	2.27%	6
5	Strongly disagree	1.14%	3
	Total	100%	264

Q24 - I frequently look for advancement within the organization



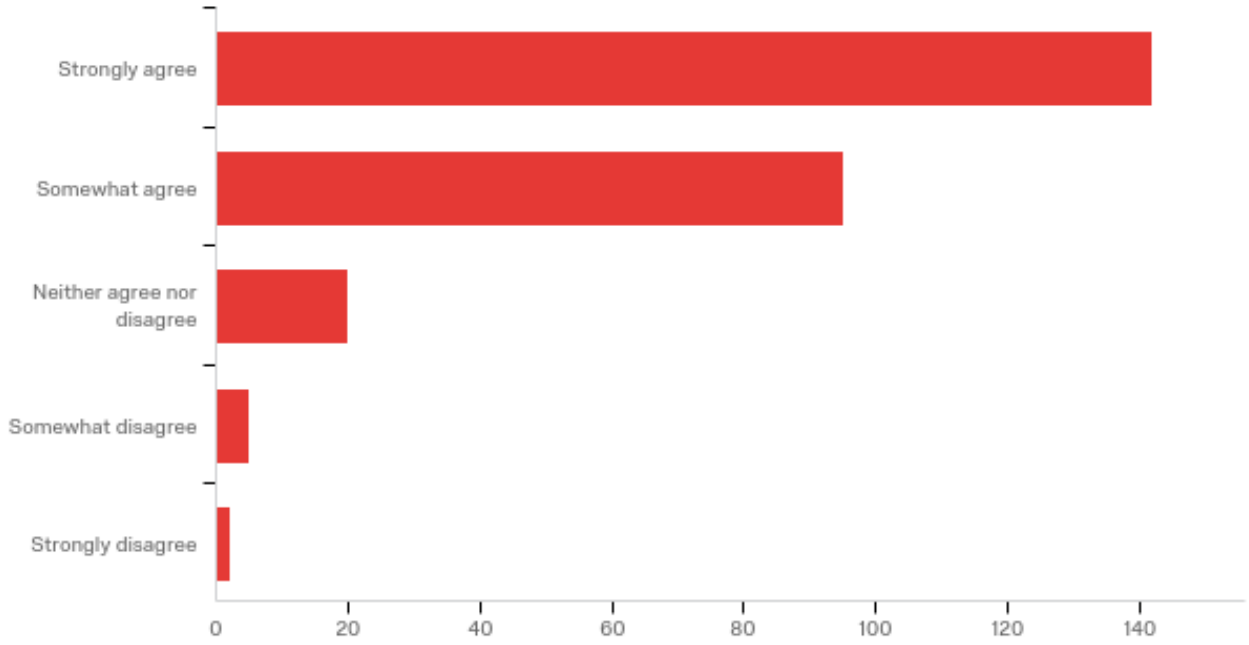
#	Answer	%	Count
1	Strongly agree	26.52%	70
2	Somewhat agree	39.77%	105
3	Neither agree nor disagree	23.48%	62
4	Somewhat disagree	8.33%	22
5	Strongly disagree	1.89%	5
	Total	100%	264

Q25 - I frequently look for opportunities outside of my current employer



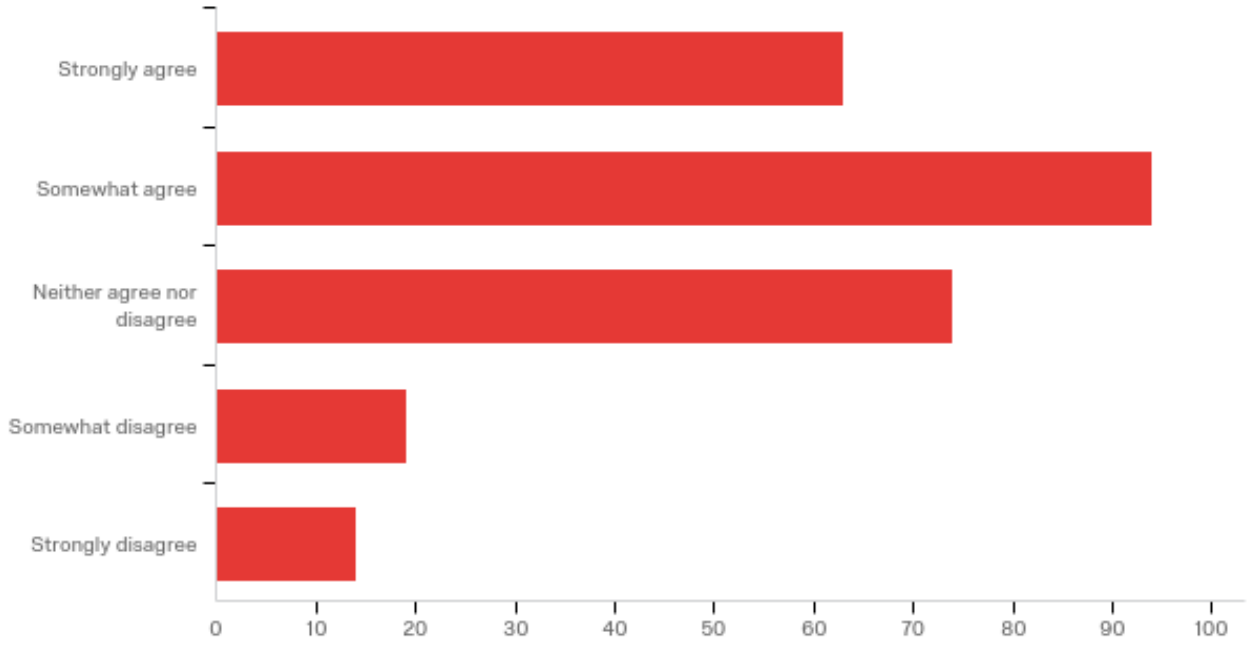
#	Answer	%	Count
1	Strongly agree	22.35%	59
2	Somewhat agree	29.55%	78
3	Neither agree nor disagree	17.42%	46
4	Somewhat disagree	20.08%	53
5	Strongly disagree	10.61%	28
	Total	100%	264

Q26 - I feel that I should take personal responsibility, good or bad, for the results of my work



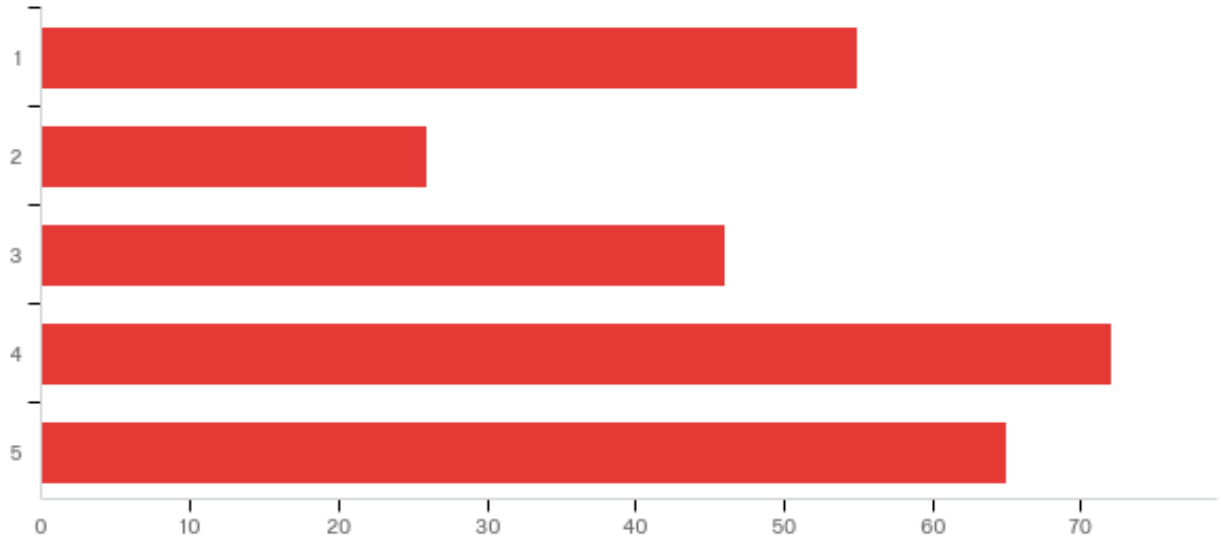
#	Answer	%	Count
1	Strongly agree	53.79%	142
2	Somewhat agree	35.98%	95
3	Neither agree nor disagree	7.58%	20
4	Somewhat disagree	1.89%	5
5	Strongly disagree	0.76%	2
	Total	100%	264

Q27 - I feel there is sufficient challenge in my job to invest in education to move to the next level



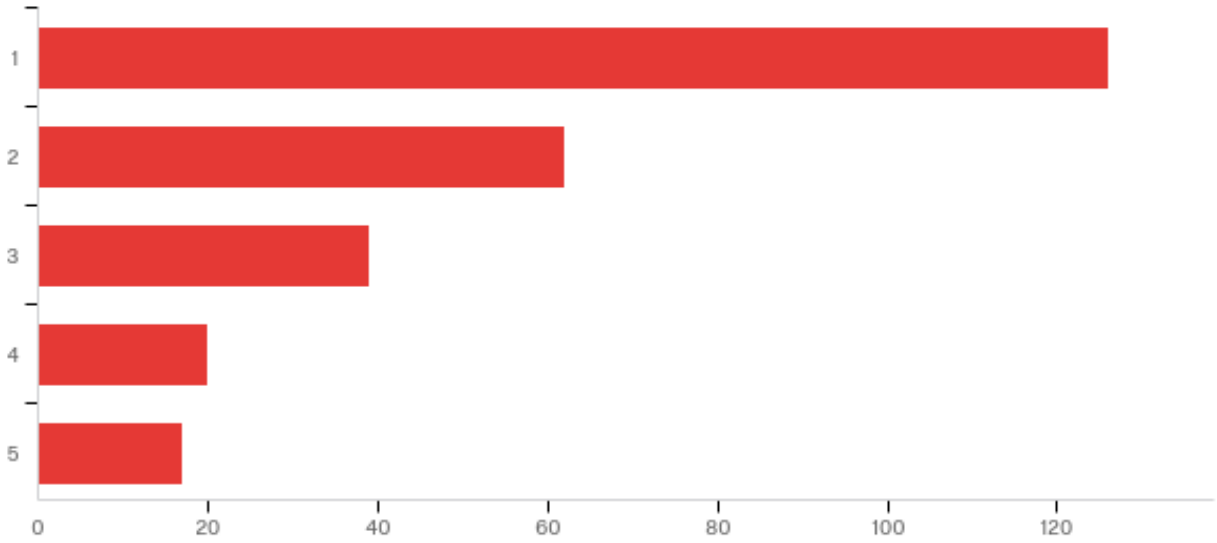
#	Answer	%	Count
1	Strongly agree	23.86%	63
2	Somewhat agree	35.61%	94
3	Neither agree nor disagree	28.03%	74
4	Somewhat disagree	7.20%	19
5	Strongly disagree	5.30%	14
	Total	100%	264

Q35 - Job A A job where you are often required to make important decisions Job B A job with pleasant people to work with 1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



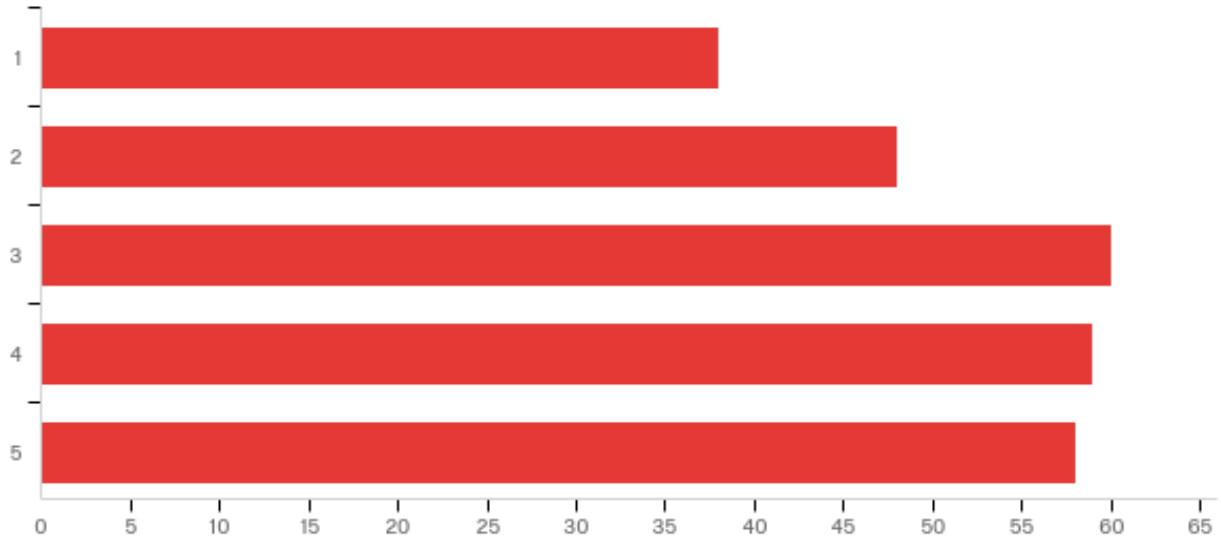
#	Answer	%	Count
1	1	20.83%	55
2	2	9.85%	26
3	3	17.42%	46
4	4	27.27%	72
5	5	24.62%	65
	Total	100%	264

Q36 - Job A A job in which greater responsibility is given to those who do the best work Job B A job in which greater responsibility is given to loyal employees who have the most seniority 1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



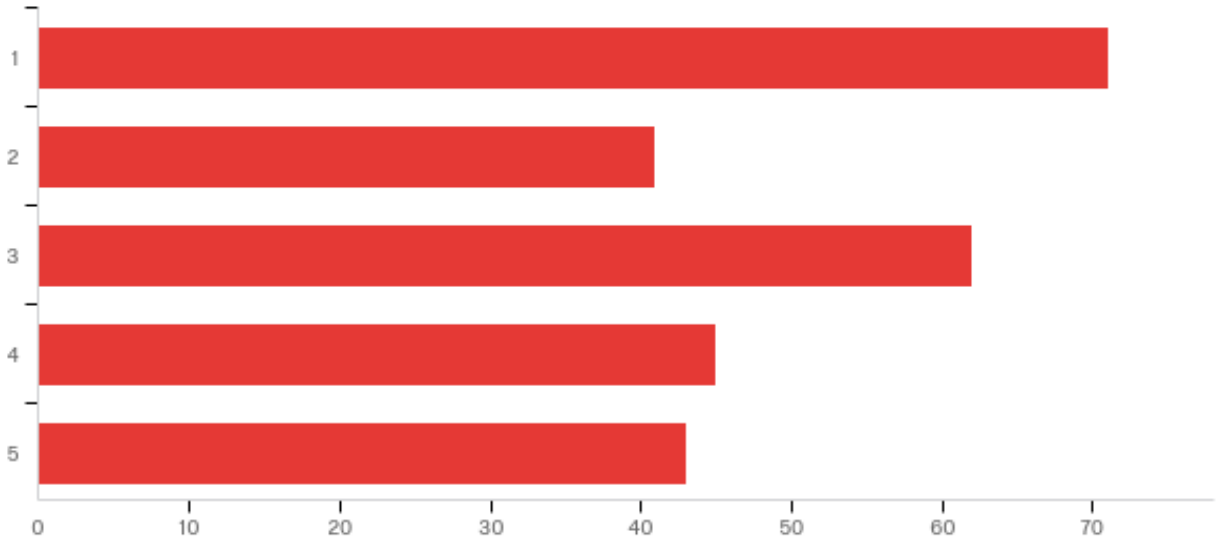
#	Answer	%	Count
1	1	47.73%	126
2	2	23.48%	62
3	3	14.77%	39
4	4	7.58%	20
5	5	6.44%	17
	Total	100%	264

Q37 - Job A A job with very satisfying team work Job B A job which allows you to use your skills and abilities to the fullest 1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



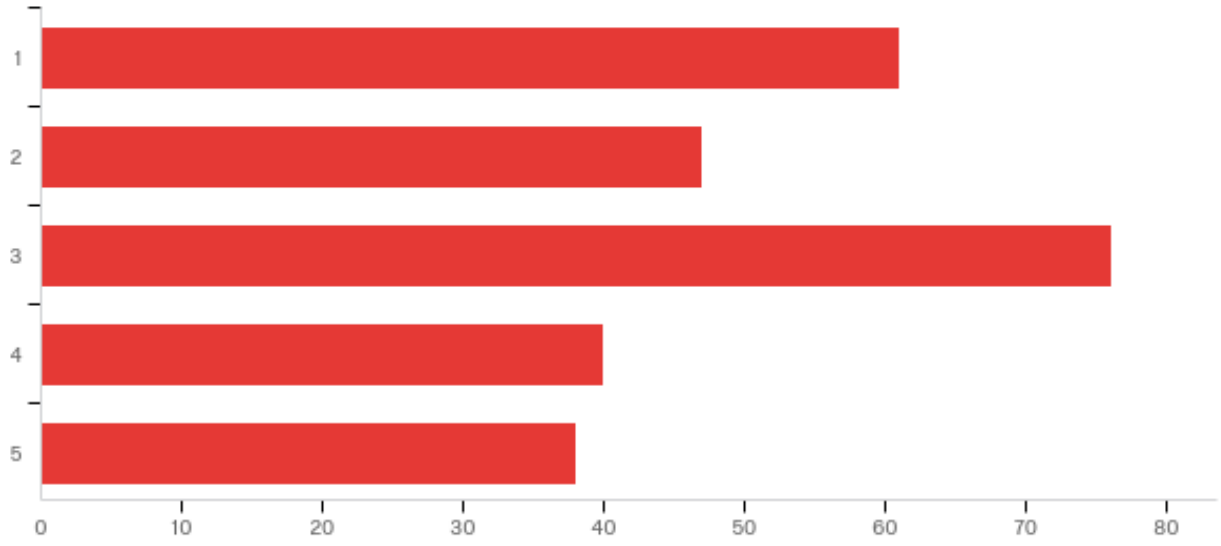
#	Answer	%	Count
1	1	14.45%	38
2	2	18.25%	48
3	3	22.81%	60
4	4	22.43%	59
5	5	22.05%	58
	Total	100%	263

Q38 - Job A A job in which there is a real chance for you to develop new skills and advance in the organization Job B A job which provides lots of vacation time and excellent benefits 1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



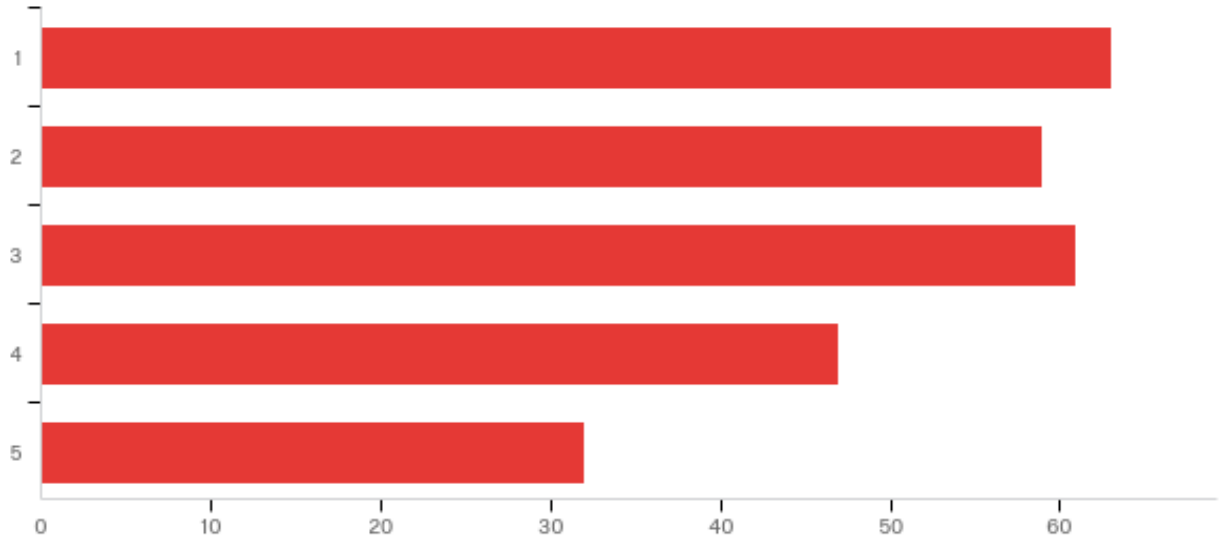
#	Answer	%	Count
1	1	27.10%	71
2	2	15.65%	41
3	3	23.66%	62
4	4	17.18%	45
5	5	16.41%	43
	Total	100%	262

Q39 - Job A A job with a supervisor that treats you fairly and respects you Job B A job which provides constant opportunities for you to learn new and interesting things 1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



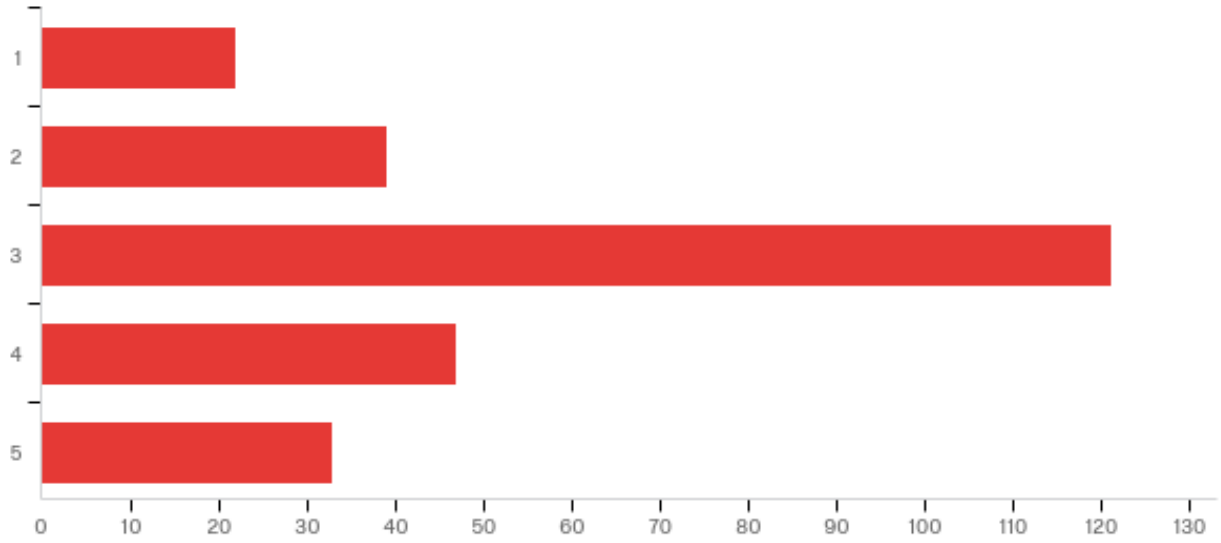
#	Answer	%	Count
1	1	23.28%	61
2	2	17.94%	47
3	3	29.01%	76
4	4	15.27%	40
5	5	14.50%	38
	Total	100%	262

Q40 - Job A A job with very good pay Job B A job where there is a considerable opportunity to be creative and innovative 1- Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



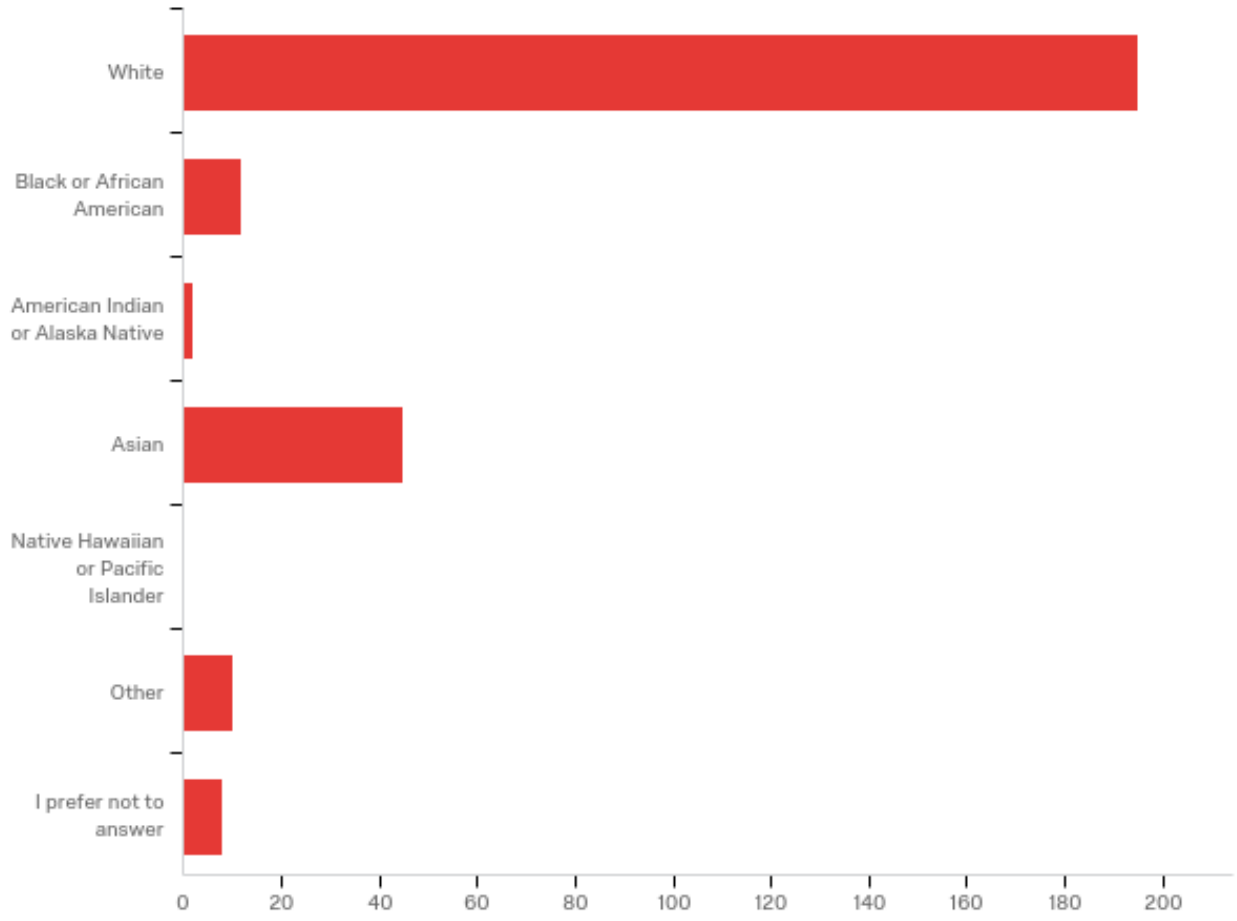
#	Answer	%	Count
1	1	24.05%	63
3	3	23.28%	61
2	2	22.52%	59
4	4	17.94%	47
5	5	12.21%	32
	Total	100%	262

Q41 - Job A A job which offers little or no challenge Job B A job that requires you to be completely isolated from co-workers 1-Strongly Prefer Job A 3-Neutral 5-Strongly prefer Job B



#	Answer	%	Count
1	1	8.40%	22
2	2	14.89%	39
3	3	46.18%	121
4	4	17.94%	47
5	5	12.60%	33
	Total	100%	262

Q47 - Choose one or more races that you consider yourself to be:



#	Choose one or more races that you consider yourself to be: - Selected Choice	Percentage
1	White	71.69%
4	Asian	16.54%
2	Black or African American	4.41%
6	Other	3.68%
7	I prefer not to answer	2.94%
3	American Indian or Alaska Native	0.74%
5	Native Hawaiian or Pacific Islander	0.00%
	Total	272

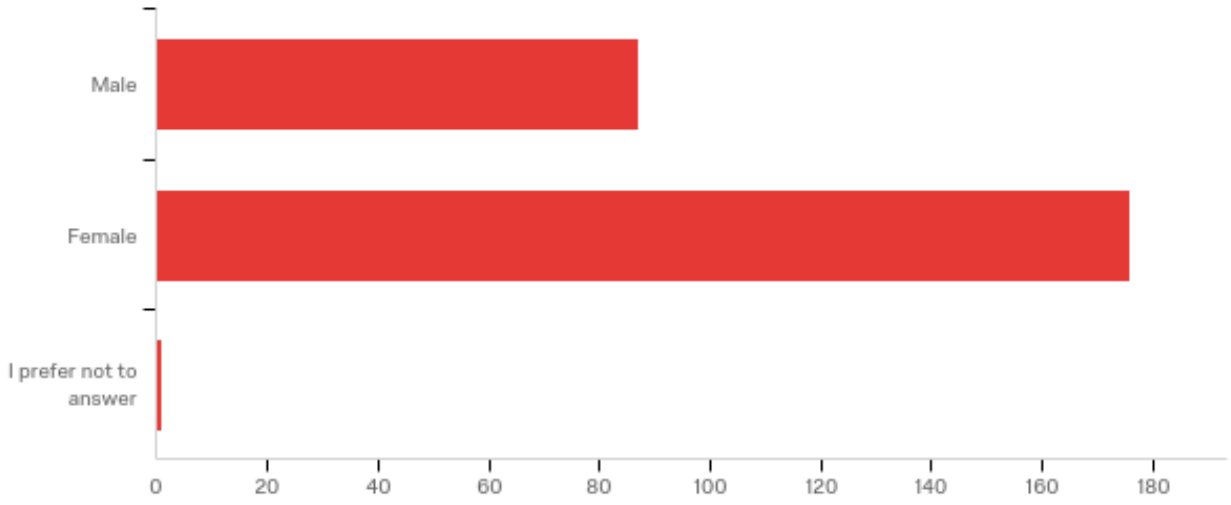
Other - Yes

Other - Text
Hispanic
Hispanic
European American
Multiracial
mixed

Other - No

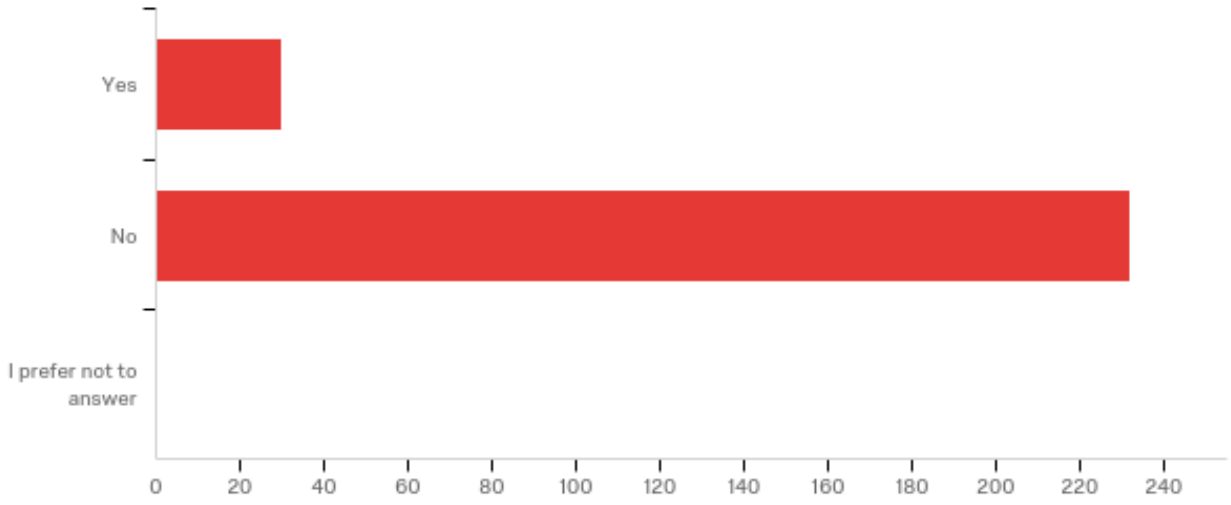
Other - Text

Q49 - What is your sex?



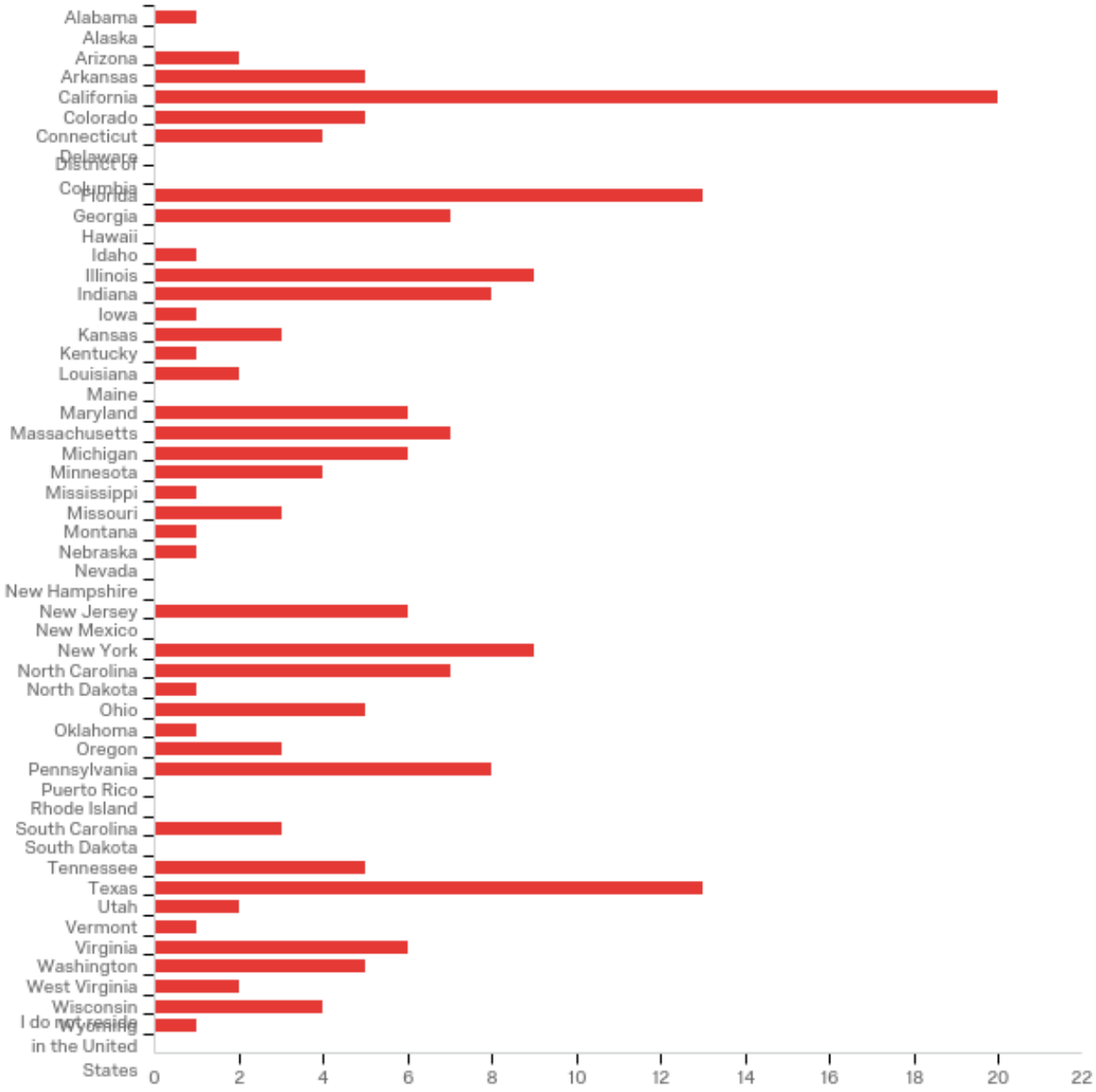
#	Answer	%	Count
1	Male	32.95%	87
2	Female	66.67%	176
3	I prefer not to answer	0.38%	1
	Total	100%	264

Q51 - Have you ever served in the US Armed Forces?



#	Answer	%	Count
1	Yes	11.45%	30
2	No	88.55%	232
3	I prefer not to answer	0.00%	0
	Total	100%	262

Q57 - 50 States, D.C. and Puerto Rico



#	Answer	%	Count
1	Alabama	0.52%	1
2	Alaska	0.00%	0
3	Arizona	1.04%	2

4	Arkansas	2.59%	5
5	California	10.36%	20
6	Colorado	2.59%	5
7	Connecticut	2.07%	4
8	Delaware	0.00%	0
9	District of Columbia	0.00%	0
10	Florida	6.74%	13
11	Georgia	3.63%	7
12	Hawaii	0.00%	0
13	Idaho	0.52%	1
14	Illinois	4.66%	9
15	Indiana	4.15%	8
16	Iowa	0.52%	1
17	Kansas	1.55%	3
18	Kentucky	0.52%	1
19	Louisiana	1.04%	2
20	Maine	0.00%	0
21	Maryland	3.11%	6
22	Massachusetts	3.63%	7
23	Michigan	3.11%	6
24	Minnesota	2.07%	4
25	Mississippi	0.52%	1
26	Missouri	1.55%	3
27	Montana	0.52%	1
28	Nebraska	0.52%	1
29	Nevada	0.00%	0
30	New Hampshire	0.00%	0
31	New Jersey	3.11%	6

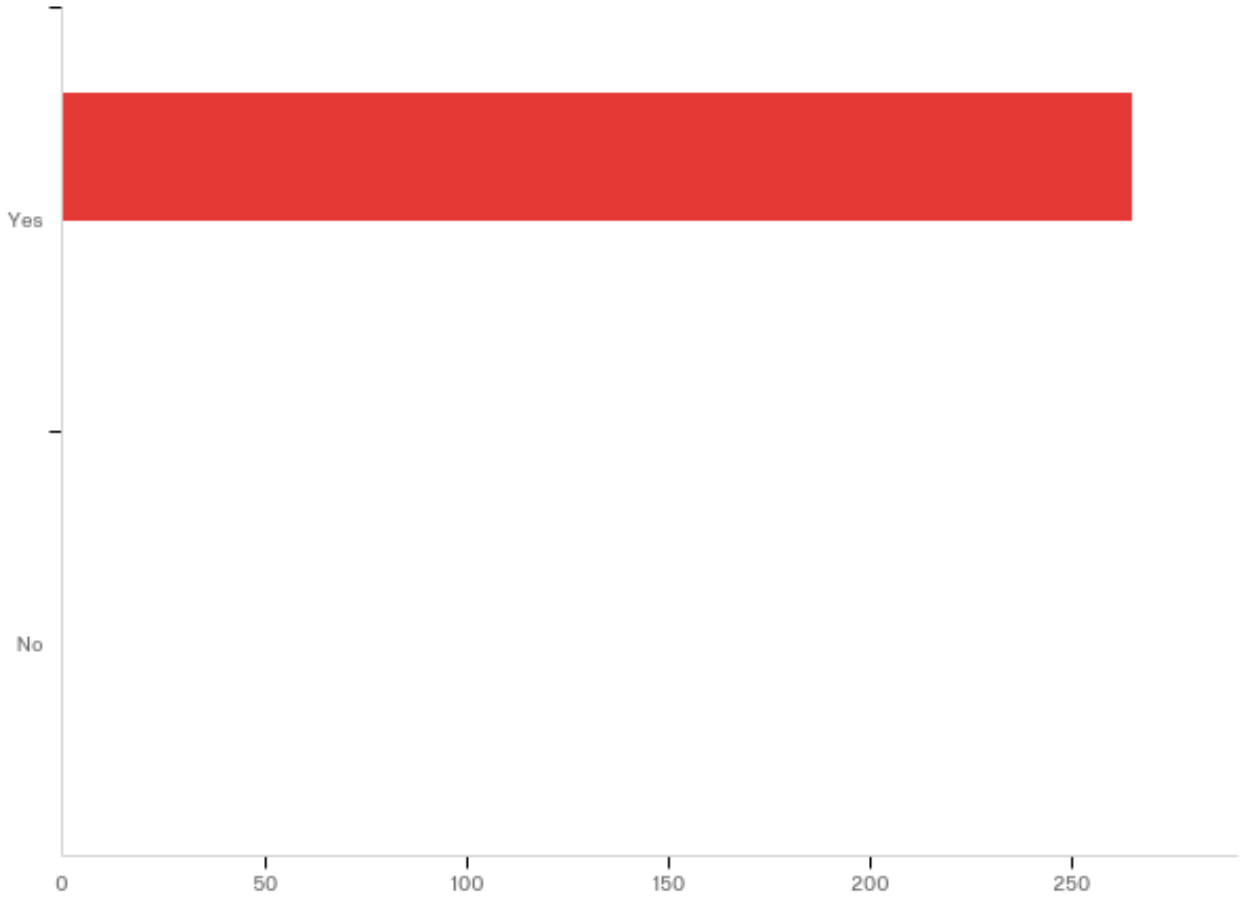
32	New Mexico	0.00%	0
33	New York	4.66%	9
34	North Carolina	3.63%	7
35	North Dakota	0.52%	1
36	Ohio	2.59%	5
37	Oklahoma	0.52%	1
38	Oregon	1.55%	3
39	Pennsylvania	4.15%	8
40	Puerto Rico	0.00%	0
41	Rhode Island	0.00%	0
42	South Carolina	1.55%	3
43	South Dakota	0.00%	0
44	Tennessee	2.59%	5
45	Texas	6.74%	13
46	Utah	1.04%	2
47	Vermont	0.52%	1
48	Virginia	3.11%	6
49	Washington	2.59%	5
50	West Virginia	1.04%	2
51	Wisconsin	2.07%	4
52	Wyoming	0.52%	1
53	I do not reside in the United States	0.00%	0
	Total	100%	193

Q60 - Georgia State University Informed Consent Title: What job characteristics are affected by managerial training in scientists that are in management roles versus scientists that are in technical roles? Principal Investigator: Patricia Ketsche Student Principal Investigator: Jamie Humphries Introduction and Key Information You are invited to take part in a research study. It is up to you to decide if you would like to take part in the study. The purpose of this study is to collect information on the effects of training on job characteristics. Your role in the study will last 15 minutes. You will be asked to do the following: answer a list of survey questions and submit the survey. Participating in this study will not expose you to any more risks than you would experience in a typical day. This study is not designed to benefit you. Overall, we hope to gain information about how managerial training impacts job characteristics of scientifically and a technically trained individuals. Purpose The purpose of the study is to gather information pertaining to job characteristics and managerial training. You are invited to take part in this research study because you are have a bachelor's degree or higher in a scientific or technical field of study. A total of 1000 people will be invited to take part in this study.

Procedures If you decide to take part, you will asked to answer an online survey only once, which will take approximately 15 minutes. Future Research Researchers will remove information that may identify you and may use your data for future research. If we do this, we will not ask for any additional consent for you. Risks In this study, you will not have any more risks than you would in a normal day of life. Benefits This study is not designed to benefit you. Overall, we hope to gain information about how managerial training impacts job characteristics of scientifically and a

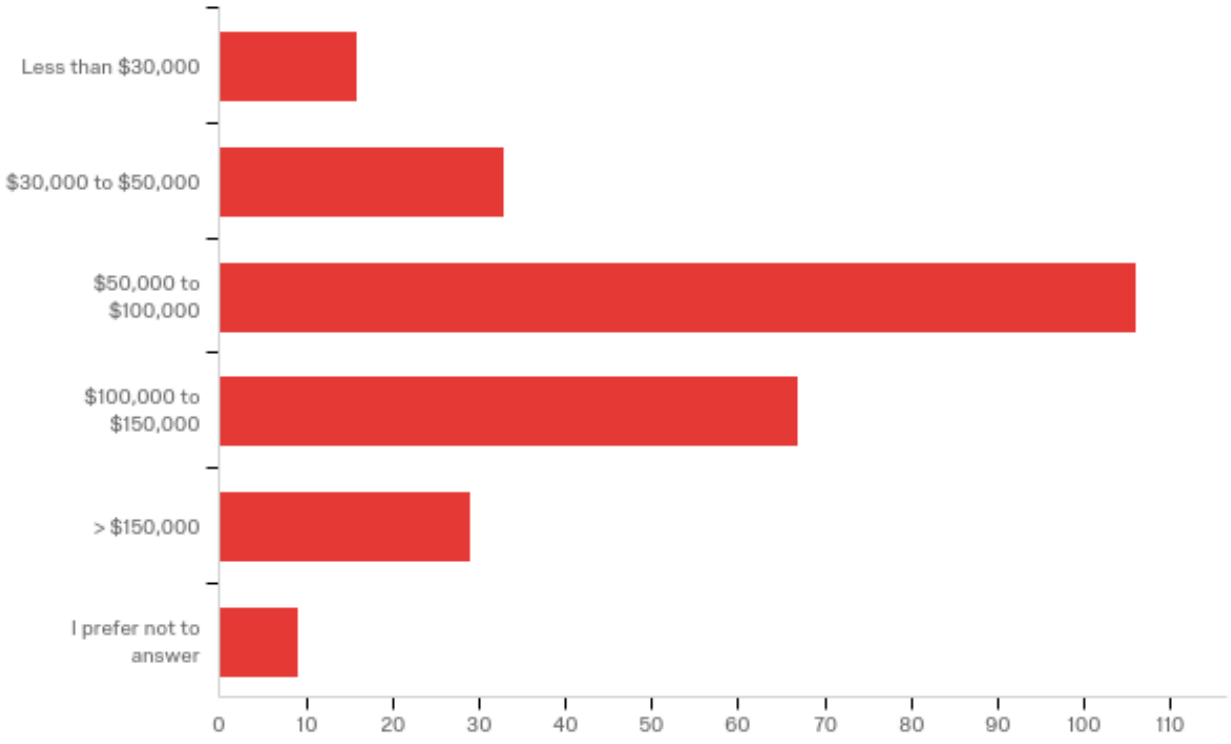
technically trained individuals. Compensation You will receive will receive an incentive based on the length of the survey, specific panelist profile and target acquisition difficulty. The specific type of rewards vary and may include cash, airline miles, gift cards, redeemable points, sweepstakes entrance and vouchers for participating in this study and completing the survey. Voluntary Participation and Withdrawal You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. You may refuse to take part in the study or stop at any time, the respondent will not be compensated if they withdraw prior to completing the survey. Confidentiality The survey is being conducted by an external third party and we will not have access to any identifying personal information at Georgia State University. We will keep the survey data private to the extent allowed by law. The following people and entities will have access to the de-identified information you provide: • Patricia Ketsche • Jamie Humphries • GSU Institutional Review Board • Office for Human Research Protection (OHRP) We will use an identification number rather than your name on study records. The information you provide will be stored password- and firewall-protected computers. When we present or publish the results of this study, we will not use your name or other information that may identify you. Contact Information Contact Jamie Humphries at 817-888-9900 or jhumphries9@student.gsu.edu • If you have questions about the study or your part in it • If you have questions, concerns, or complaints about the study Contact the GSU Office of Human Research Protections at 404-413-3500 or irb@gsu.edu • if you have questions about your rights as a research

participant • if you have questions, concerns, or complaints about the research Consent We will give you a copy of this consent form to keep. If you are willing to volunteer for this research, please check "Yes" below.



#	Question	Yes		No		Total
1	Yes	100.00%	265	0.00%	0	265
2	No	0.00%	0	0.00%	0	0

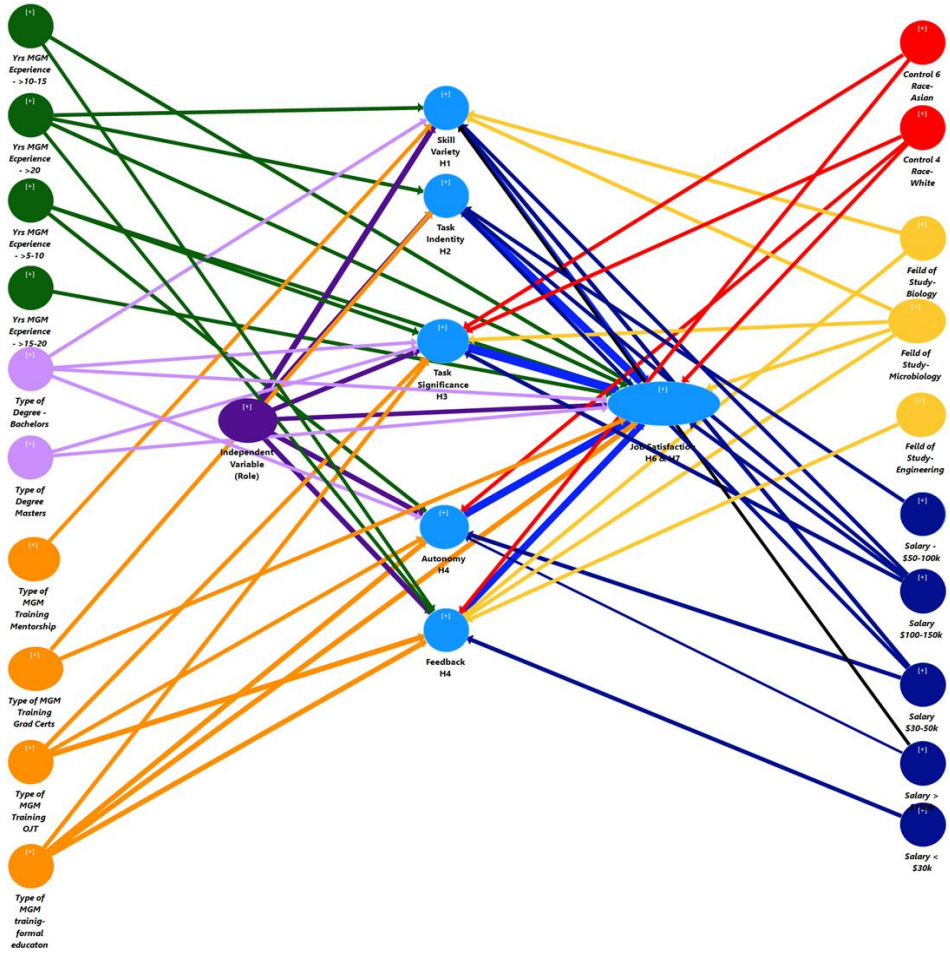
Q63 - Please indicate the answer that includes your annual income in (previous year) before taxes.



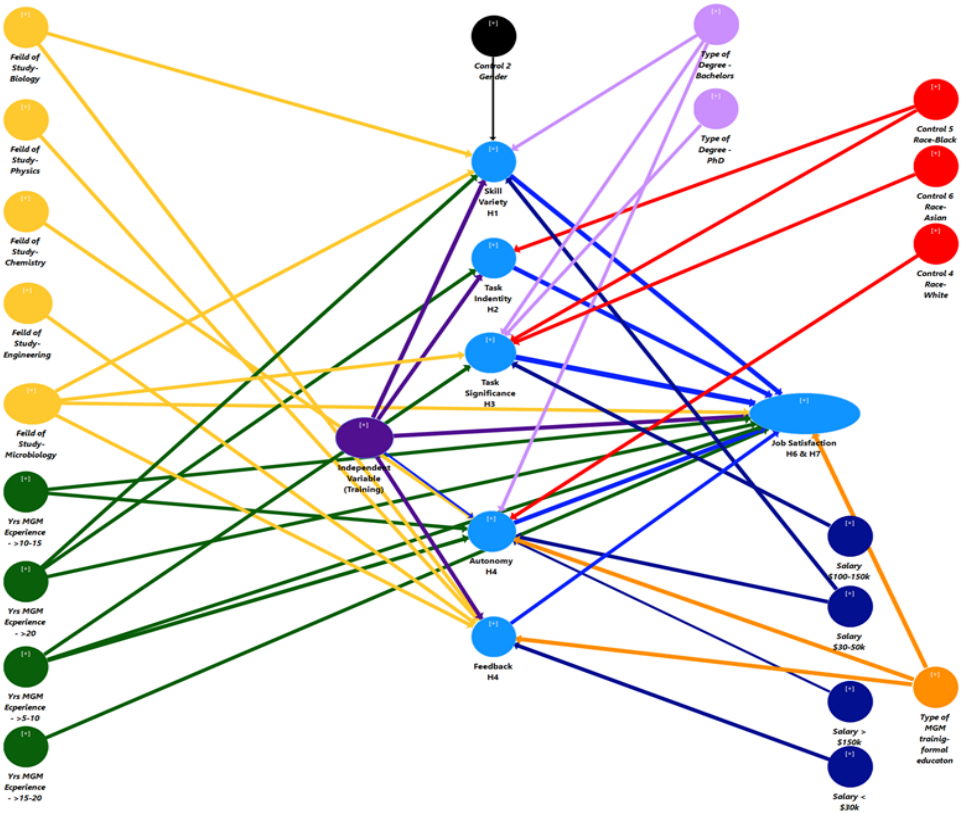
#	Please indicate the answer that includes your annual income in (previous year) before taxes.	Percentage
1	Less than $30,000	6.15%
2	$30,000 to $50,000	12.69%
3	$50,000 to $100,000	40.77%
4	$100,000 to $150,000	25.77%
5	> $150,000	11.15%
6	I prefer not to answer	3.46%
	Total	260

Appendix E: Smart PLS Models

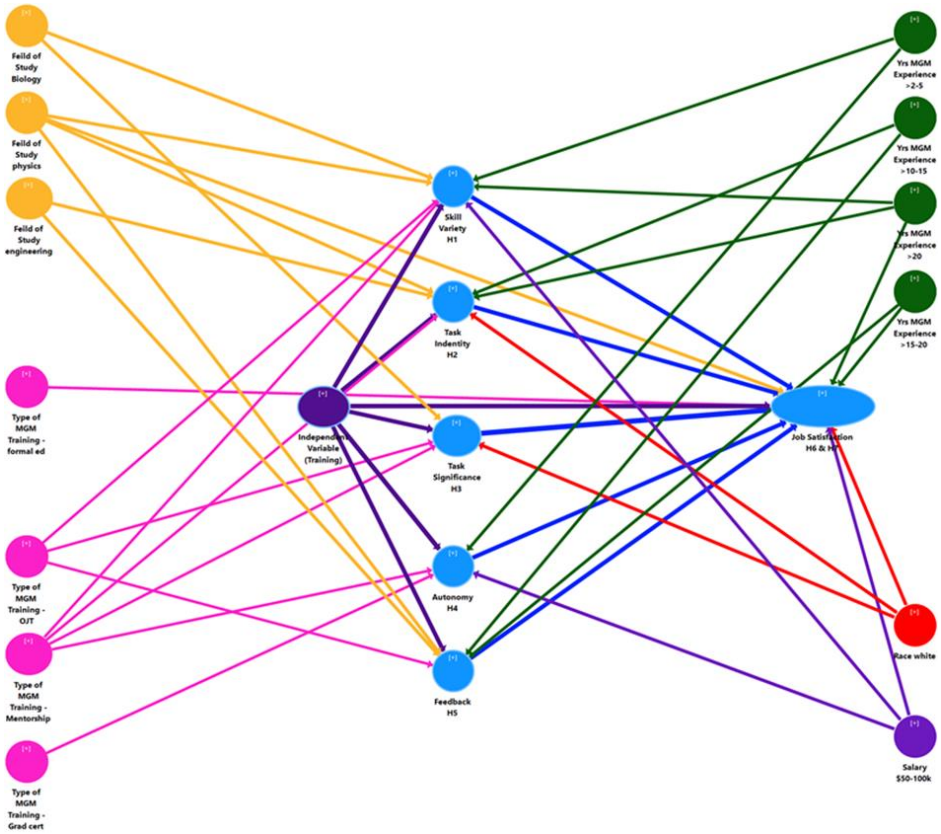
Smart PLS Model H1A-5A and H6



Smart PLS Model H1B-5B



Smart PLS Model H1C-5C and H7



Appendix F: Heterotrait-Monotrait Ratio Tables

Heterotrait-Monotrait Ratio Table Section A

	Autonomy_H4	Feild of Study-Engineering	Race-White	Race-Black	Race-Asian	Feild of Study-Biology	Feild of Study-Microbiology	Feedback_H4	Independent_Variable_(Role or Training)	Job Satisfaction_H6 & H7	Salary $100-150k	Salary $30-50k	Salary $50-100k	Salary - $150K	Skill Variety_H1	Task Indentity_H2	Task Significance_H3	Type MGM Training - OJT	Type of Degree - Bachelors	Type of Degree - PhD	Type of MGM Training - Formal Ed	Type of MGM Training - Grad Certs	Type of degree - Masters	Yrs - MGM -Experience >15-20	Yrs - MGM Experience >10-15	Yrs - MGM Experience >20
Autonomy_H4																										
Feild of Study-Engineering	0.113																									
Race-White	0.187	0.011																								
Race-Black	0.078	0.054	0.287																							
Race-Asian	0.14	0.064	0.682	0.052																						
Feild of Study-Biology	0.197	0.254	0.11	0.011	0.032																					
Feild of Study-Microbiology	0.092	0.017	0.129	0.027	0.028	0.046																				
Feedback_H4	0.715	0.17	0.02	0.056	0.037	0.127	0.138																			
Independent_Variable_(Role)	0.356	0.06	0.087	0.009	0.155	0.073	0.114	0.338																		
Job Satisfaction_H6 & H7	0.335	0.08	0.089	0.065	0.089	0.065	0.037	0.59	0.283																	
Salary $100-150k	0.299	0.06	0.031	0.087	0.018	0.069	0.071	0.13	0.153	0.08																
Salary $30-50k	0.038	0.04	0.034	0.085	0.052	0.112	0.073	0.06	0.154	0.053	0.218															
Salary $50-100k	0.359	0.04	0.043	0.151	0.021	0.147	0.122	0.118	0.048	0.072	0.491	0.321														
Salary - $150K	0.369	0.02	0.1	0.024	0.094	0.245	0.084	0.066	0.105	0.079	0.214	0.14	0.315													
Skill Variety_H1	0.865	0.019	0.003	0.015	0.007	0.206	0.115	0.389	0.13	0.215	0.176	0.021	0.204	0.167												
Task Indentity_H2	0.518	0.05	0.019	0.094	0.066	0.029	0.044	0.489	0.175	0.197	0.11	0.02	0.056	0.078	0.331											
Task Significance_H3	0.997	0.095	0.354	0.378	0.383	0.237	0.234	0.912	0.511	1.069	0.427	0.217	0.166	0.13	1.033	0.477										
Type MGM Training - OJT	0.11	0.099	0.011	0.068	0.056	0.019	0.149	0.305	0.097	0.195	0.026	0.052	0.044	0.112	0.209	0.162	0.355									
Type of Degree - Bachelors	0.313	0.048	0.029	0.124	0.049	0.186	0.056	0.055	0.002	0.104	0.143	0.148	0.148	0.221	0.19	0.069	0.432	0.091								
Type of Degree - PhD	0.085	0.142	0.089	0.06	0.046	0.092	0.211	0.062	0.005	0.082	0.074	0.096	0.074	0.063	0.097	0.057	0.131	0.065	0.254							
Type of MGM Training - Formal Ed	0.119	0.037	0.009	0.158	0.005	0.131	0.058	0.041	0.026	0.081	0.025	0.033	0.116	0.089	0.038	0.006	0.385	0.164	0.111	0.056						
Type of MGM Training - Grad Certs	0.143	0.169	0.036	0.11	0.072	0.053	0.042	0.161	0.076	0.152	0.034	0.125	0.013	0.037	0.023	0.151	0.128	0.257	0.01	0.063	0.329					
Type of degree - Masters	0.23	0.129	0.034	0.005	0.056	0.185	0.024	0.027	0.032	0.123	0.136	0.059	0.157	0.177	0.188	0.118	0.413	0.149	0.699	0.222	0.093	0.062				
Yrs - MGM -Experience >15-20	0.12	0.055	0.092	0.037	0.103	0.122	0.051	0.067	0.102	0.117	0.086	0.086	0.116	0.214	0.049	0.048	0.125	0.014	0.159	0.057	0.106	0.018	0.069			
Yrs - MGM Experience >10-15	0.225	0.02	0.093	0.094	0	0.103	0.082	0.171	0.221	0.138	0.311	0.138	0.132	0.011	0.062	0.135	0.193	0.064	0.146	0.043	0.148	0.173	0.161	0.082		
Yrs - MGM Experience >20	0.242	0.011	0.075	0.057	0.116	0.162	0.057	0.025	0.073	0.169	0.03	0.096	0.148	0.442	0.225	0.166	0.149	0.056	0.207	0.002	0.065	0.031	0.238	0.057	0.092	
Yrs - MGM Experience >5-10	0.206	0.042	0.089	0.02	0.134	0.052	0.01	0.18	0.221	0.25	0.007	0.138	0.153	0.001	0.109	0.055	0.411	0.037	0.085	0.101	0.04	0.083	0.006	0.117	0.189	0.132

Heterotrait-Monotrait Ratio Table Section B

	Autonomy_H4	Feild of Study-Physics	Feild of Study-Engineering	Gender	Race-White	Race-Black	Race-Asian	Feild of Study-Biology	Feild of Study-Microbiology	Feild of Study-Chemistry	Feedback_H4	Independent_Variable_(Role or Training)	Job Satisfaction_H6 & H7	Salary $100-150k	Salary $30-50k	Salary <$30k	Salary >$150k	Skill Variety_H1	Task Indentity_H2	Task Significance_H3	Type of Degree - Bachelors	Type of Degree - PhD	Type of MGM trainig-formal educaton	Yrs MGM Ecperience - >10-15	Yrs MGM Ecperience - >15-20	Yrs MGM Ecperience - >20
Autonomy_H4																										
Feild of Study-Physics	0.144																									
Feild of Study-Engineering	0.113	0.02																								
Gender	0.296	0.175	0.088																							
Race-White	0.187	0.042	0.011	0.04																						
Race-Black	0.078	0.054	0.054	0.038	0.287																					
Race-Asian	0.14	0.033	0.064	0.071	0.682	0.052																				
Feild of Study-Biology	0.197	0.259	0.254	0.312	0.11	0.011	0.032																			
Feild of Study-Microbiology	0.092	0.039	0.017	0.096	0.129	0.027	0.028	0.046																		
Feild of Study-Chemistry	0.346	0.018	0.128	0.248	0.044	0.112	0.196	0.442	0.058																	
Feedback_H4	0.715	0.115	0.17	0.177	0.02	0.056	0.037	0.127	0.138	0.03																
Independent_Variable_(Role or Training)	0.322	0.065	0.01	0.139	0.057	0.064	0.123	0.099	0.11	0.225	0.229															
Job Satisfaction_H6 & H7	0.335	0.141	0.08	0.115	0.089	0.065	0.089	0.065	0.037	0.084	0.59	0.21														
Salary $100-150k	0.299	0	0.06	0.108	0.031	0.087	0.018	0.069	0.071	0.238	0.13	0.155	0.08													
Salary $30-50k	0.359	0.002	0.04	0.248	0.043	0.151	0.021	0.147	0.122	0.189	0.118	0.04	0.072	0.491												
Salary <$30k	0.197	0.097	0.092	0.097	0.05	0.026	0.026	0.048	0.171	0.085	0.099	0.049	0.074	0.141	0.208											
Salary >$150k	0.369	0.03	0.02	0.394	0.1	0.024	0.094	0.245	0.084	0.196	0.066	0.121	0.079	0.214	0.315	0.091										
Skill Variety_H1	0.865	0.048	0.019	0.245	0.003	0.015	0.007	0.206	0.115	0.154	0.389	0.117	0.215	0.176	0.204	0.011	0.167									
Task Indentity_H2	0.518	0.034	0.05	0.117	0.019	0.094	0.066	0.029	0.044	0.007	0.489	0.091	0.197	0.11	0.056	0.081	0.078	0.331								
Task Significance_H3	0.999	0.126	0.095	0.264	0.354	0.378	0.383	0.237	0.234	0.264	0.997	0.557	0.987	0.427	0.166	0.1	0.13	0.913	0.477							
Type of Degree - Bachelors	0.313	0.018	0.048	0.189	0.029	0.124	0.049	0.186	0.056	0.287	0.055	0.007	0.104	0.143	0.148	0.114	0.221	0.19	0.069	0.432						
Type of Degree - PhD	0.085	0.087	0.142	0.02	0.089	0.06	0.046	0.092	0.211	0.156	0.062	0.063	0.082	0.074	0.074	0.007	0.063	0.097	0.057	0.131	0.254					
Type of MGM trainig- formal educaton	0.162	0.1	0.05	0.159	0.092	0.109	0.053	0.088	0.05	0.078	0.131	0.357	0.097	0.07	0.163	0.06	0.08	0.136	0.097	0.1	0.14	0.094				
Yrs MGM Ecperience - >10-15	0.225	0.051	0.02	0.197	0.093	0.094	0	0.103	0.082	0.078	0.171	0.143	0.138	0.311	0.132	0.089	0.011	0.062	0.135	0.193	0.146	0.043	0.137			
Yrs MGM Ecperience - >15-20	0.12	0.054	0.055	0.042	0.092	0.037	0.103	0.122	0.051	0.09	0.067	0.103	0.117	0.086	0.116	0.055	0.214	0.049	0.048	0.125	0.159	0.057	0.031	0.082		
Yrs MGM Ecperience - >20	0.242	0.083	0.011	0.216	0.075	0.057	0.116	0.162	0.057	0.227	0.025	0.051	0.169	0.03	0.148	0.062	0.442	0.225	0.166	0.149	0.207	0.002	0.134	0.092	0.057	
Yrs MGM Ecperience - >5-10	0.206	0.03	0.042	0.074	0.089	0.02	0.134	0.052	0.01	0.05	0.18	0.241	0.25	0.007	0.153	0.128	0.001	0.109	0.055	0.411	0.085	0.101	0.051	0.189	0.117	0.132

Heterotrait-Monotrait Ratio Table Section C

	Autonomy_H4	Feedback_H4	Feild of Study Biology	Feild of Study engineering	Feild of Study physics	Independent_Variable_(Role or Training)	Job Satisfaction_H6 & H7	Race white	Salary $50-100k	Skill Variety_H1	Task Indentity_H2	Task Significance_H3	Type of MGM Training - Mentorship	Type of MGM Training - Grad cert	Type of MGM Training - OJT	Type of MGM Training - formal ed	Yrs MGM Experience >10-15	Yrs MGM Experience >15-20	Yrs MGM Experience >2-5
Autonomy_H4																			
Feedback_H4	0.924																		
Feild of Study Biology	0.258	0.156																	
Feild of Study engineering	0.126	0.279	0.265																
Feild of Study physics	0.214	0.046	0.131	0.027															
Independent_Variable_(Training)	0.051	0.187	0.089	0.109	0.202														
Job Satisfaction_H6 & H7	0.265	0.563	0.04	0.129	0.263	0.143													
Race white	0.055	0.098	0.097	0.004	0.1	0.089	0.081												
Salary $50-100k	0.343	0.074	0.268	0.026	0.021	0.026	0.204	0.003											
Skill Variety_H1	0.943	0.34	0.194	0.098	0.035	0.027	0.072	0.105	0.187										
Task Indentity_H2	0.431	0.471	0.08	0.14	0.055	0.184	0.138	0.081	0.054	0.212									
Task Significance_H3	4.609	3.066	0.62	0.476	0.18	0.466	1.599	1.196	0.482	2.068	0.324								
Type of MGM Training - Mentorship	0.224	0.197	0	0.061	0.153	0.822	0.108	0.071	0.097	0.149	0.018	0.255							
Type of MGM Training -Grad cert	0.201	0.138	0.084	0.197	0.148	0.484	0.114	0.028	0.011	0.041	0.157	0.657	0.397						
Type of MGM Training -OJT	0.209	0.449	0.031	0.113	0.367	0.393	0.239	0.061	0.077	0.255	0.124	0.811	0.323	0.205					
Type of MGM Training -formal ed	0.044	0.056	0.174	0.041	0.159	0.382	0.163	0.002	0.095	0.052	0.021	0.624	0.314	0.553	0.222				
Yrs MGM Experience >10-15	0.243	0.192	0.104	0.026	0.14	0.166	0.129	0.163	0.186	0.044	0.162	0.479	0.166	0.142	0.039	0.155			
Yrs MGM Experience >15-20	0.122	0.172	0.082	0.074	0.083	0.012	0.21	0.077	0.16	0.002	0.103	0.295	0.001	0.055	0.032	0.119	0.13		
Yrs MGM Experience >2-5	0.245	0.229	0.035	0.119	0.077	0.001	0.064	0.026	0.007	0.156	0.038	0.37	0.003	0.046	0.054	0.122	0.278	0.159	
Yrs MGM Experience >20	0.289	0.076	0.106	0.035	0.088	0.072	0.366	0.021	0.118	0.207	0.252	0.426	0.141	0.103	0.058	0.053	0.137	0.079	0.168

VITA

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